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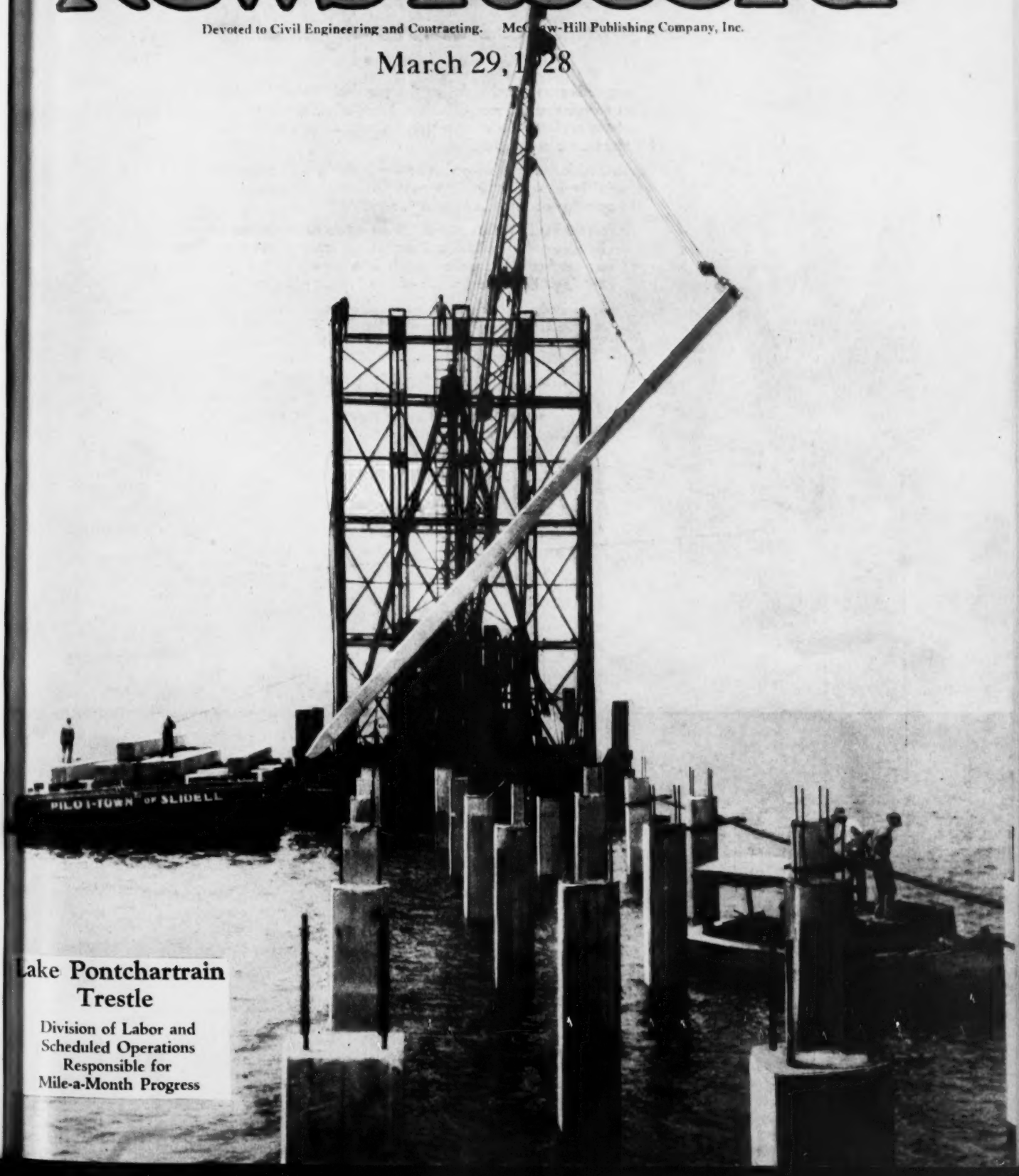

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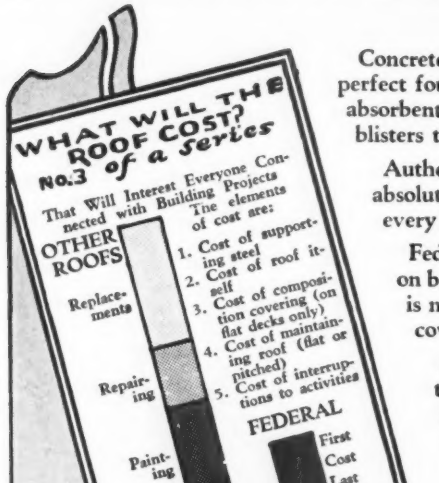

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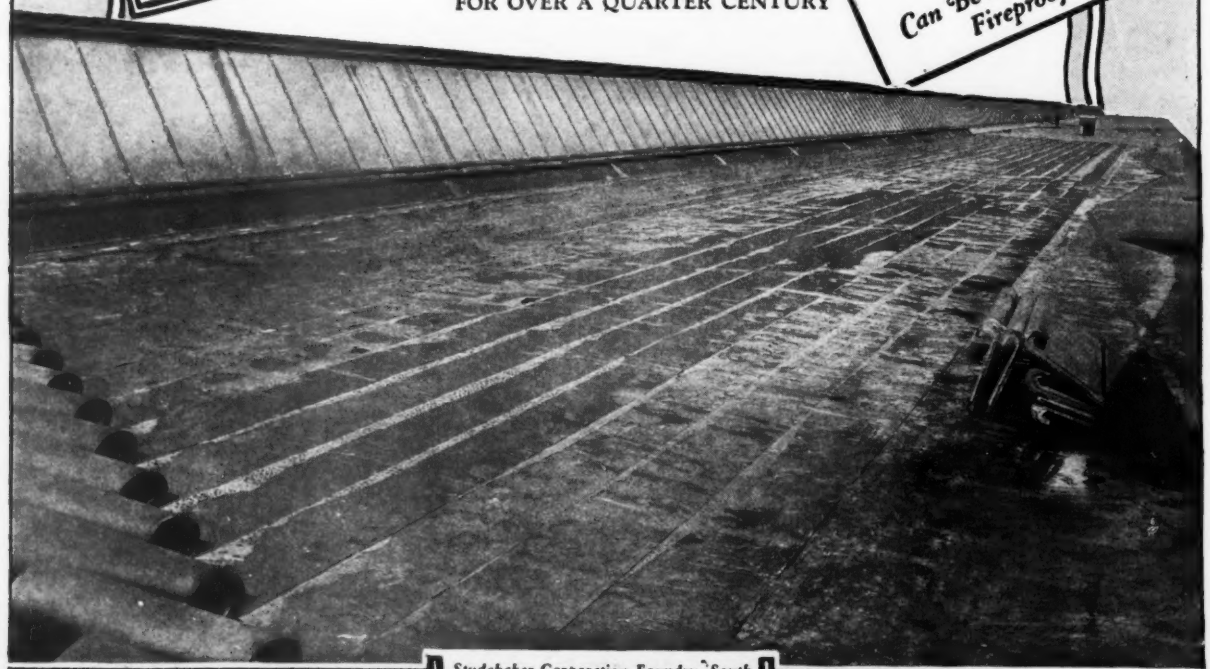

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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The Engineer's Faith

IN SO GRAVE a situation as that presented by the failure of the St. Francis dam it is not surprising that little information has come out, to add to that given last week. Several groups of able investigators are at work, and their studies necessarily call for time and caution. Meantime it is startling to read the chief engineer's statement at the coroner's inquest. He visited the dam on the day before the failure, he said, because the keeper had reported "a new leak," a flow of muddy water. In dam or levee, muddy seepage has ever been a danger sign. But apparently the engineers did not confirm the keeper's observation, for they gave no warning and even reassured the keeper. Their confidence in their work was supreme. More than twenty years ago, just before the ill-fated Quebec Bridge carried nearly a hundred men down in its collapse, an inspector gave warning of danger in the buckling webs of the truss chords; but the resident engineer, confident in his work, saw no danger. A strange parallel! It is a reminder that though the engineer must have faith in his structure—bridge or dam or foundation—there may come a time when he must doubt, by the proof of facts, or he faces disaster.

Spring Road Bids

MARCH madness has again seized upon highway contractors. The first calls of the season for bids to build the new roads of 1928 have sounded, and to get in at the bidding contractors have rivaled the rush of gold hunters to a new strike. The figures are interesting. In New York on March 21 no less than 218 bidders strove for fourteen contracts for building about 70 miles of highway. The ratio of bids to contracts was more than fifteen to one. The engineers estimated the cost of the work as $4,193,563; the sum of the low bids was $3,103,046 and that of the high bids was $3,846,875. Job-hungry contractors were willing to do the work for more than a million dollars less than its cost as estimated by the state highway engineers. It was the same in Indiana: at the first call for bids of the year 33 contractors bid for six road jobs aggregating 61 miles of 18-ft. road. The ratio of bidders to jobs was five to one. In these figures contractors and engineers can find little improvement over the wild scrambles of previous springs, which left their trail of loss and default across the record of highway contracting.

A Week of Welding

THE biggest week to date in the field of structural welding has just been recorded. Two large and noteworthy structures were completed, a factory in Philadelphia and a through-truss railroad bridge at Chicopee Falls, Mass. Both involved significant progress in the art, moreover. The details were worked out with a skill far ahead of that heretofore shown in welded structures, and their application by due combination of shop and field welding revealed the thoroughly practical thinking that is being brought to bear on the problem at the present time. In the light of these performances it is fair to look forward to a steadily and rapidly extending field. Already plans are well advanced for the use of welding in several high city buildings, and the adjustment of building codes to the new art is progressing. In all this growth the essential place of welding as a companion to riveting for the joining of structural steel parts is progressively working itself out.

Learning by Errors

AN INCIDENTAL point of much value was brought out by the Chicopee Falls bridge. Rarely do engineers, or members of other professions for that matter, admit in public that their work on any of their undertakings was not wholly perfect. Papers read before technical societies are apt to relate that the work under discussion went forward with clocklike regularity along the lines laid down in advance, by virtue of faultless planning and supervision. It is refreshing, then, to hear some one frankly admit, as did Gilbert D. Fish last week in describing the Chicopee Falls work at a society meeting, that many of his carefully worked-out details of design had been found unsuitable under practical conditions and would be changed if the work were to be repeated. One might expect, of course, that many mistakes would be made in a relatively new field like that of the application of welding to structural steel construction, but it is also true that mistakes are made in all fields of engineering. There is no good reason for concealing any of them, but false pride keeps many of us from doing so. To pass on to our fellow engineers through articles or papers the benefit of experience gained through our successes alone is to give but half, and in some ways the poorer half.

Back Into Line

RESTORATION of control over plans for sewerage and sewage disposal to the New York State Department of Health puts that state back in line not only with its earlier practice but also with the other states of the Union. The transfer of this work to the state engineer, a few years ago, fitted into a theory held by some, including the only engineer who had ever been a member of the state Senate, that all the engineering work of the state should be centralized and that it was objectionable if not disgraceful for an engineer to be directed by a doctor. No claim that the work has not been done well under the state engineer has ever come to our attention—the work has continued under the same engineer ever since the transfer; but some duplication of work and division of responsibility has come from the change. The work now goes back to its point of origin, the health department, in accordance with general practice as regards

state control of sanitation. The object of such control being health protection, it is logical to centralize it in the health department, but in most states that has not precluded intrusting engineering phases to engineers.

Notable Trestle Building

THE summit of skill in organizing construction is developed where a repetition of duplicate operations is required. A notable illustration is steel or concrete tall building construction. Here we have repetition of operations and organized co-ordination in their highest aspects in construction. Close on the heels of building comes paved-road construction, with the added requirement that with the scheduling of operations in time, place and order there has to be precise co-ordination of many and elaborate equipment units. Now road-trestle, or causeway, building is crowding for a position in the forward ranks. The Lake Pontchartrain trestle described in this issue is one of several examples. The number of plant units employed on this pile trestle is seldom exceeded in a construction operation, and not even in laying concrete pavement is the repetition of duplicate operations greater. As in concrete road building, none of the construction procedures was new. Molding and driving precast concrete piles, setting forms for and pouring concrete in a slab and girder deck, and even combining precast and poured-in-place concrete railing, have all been familiar operations; the construction marvel was the duplication of these operations hundreds and thousands of times to complete a 700-span structure almost five miles long at a speed not often exceeded in laying a plain concrete road slab. There was adequate equipment, but the outstanding tool of the contractor in getting speed was a close co-ordination of operations.

Complete the No-Parking Test

WHEN Chicago put into effect a no-parking ordinance for the loop or downtown district traffic, officials as well as thousands of laymen in other parts of the country felt that a forward step had been taken toward elimination of traffic congestion. They felt that the example would be of sufficient weight that in their own home town they could also ban parking where parking had become a nuisance and a serious hindrance to legitimate use of the streets. Chicago spent $50,000 to get the facts, and then devoted a year to educating the officials and the public to a reception of the idea. Finally the City Council passed the ordinance, but with the distinct understanding that it was to be given at least a three months' trial. Two months of the three have passed. Most of the opponents have subsided, but there remain a few die-hards and in addition a number of reasonable objectors—such bodies as the Automobile Trade Association—who contend that automobiles are discriminated against in favor of trucks and taxicabs. To deal with these objections, actual facts as to benefits obtained in the way of speeding up traffic are now being obtained. It is not proposed to deal with arguments or complaints on the basis of snap opinion. New traffic surveys are to tell just how traffic is accelerated and how business has been affected. From their results a true engineering balance can be set up, and the facts judged as to the greatest good to the greatest number. This method of determination is of great interest because the pressure to repeal the ordinance has not been easy to resist. Its final results will be of inestimable value to every community.

$Q = Av$

THERE is a simple hydraulic formula, the simplest one known, which says that quantity of flow, Q, is the product of area of cross-section A multiplied by velocity of flow v. It applies to small pipes and large rivers, and the Mississippi is no exception. The formula expresses a truth as inexorable as the laws of gravity, as axiomatic as the multiplication table or the value of π, all of them things which Congress cannot change by edict or Acts. New Mexico did try a few years ago to make a an even 3, to reduce the strain on the brains of its high-school students, but the attempt did not succeed. Congress is now working on the $Q = Av$ formula in a somewhat similar spirit.

The Reid bill, for example, calls for definite gage heights on the Mississippi, and the engineers are to say to the unruly flood waters, "Thus far only." If we lived in old China, presumably a head-chopping bee would be the duly authorized punishment of the delinquent engineers whenever the elements exercised their prerogative and sent along a larger Q than velocity times the available area of cross-section below the prescribed gage height. When legislators suddenly become consulting engineers and decide upon the greatest hydraulic problem of the ages without giving competent hydraulic engineers a reasonable time to solve the problem, the situation is really unthinkable.

No one knows at all definitely how much water a floodway of the magnitude of that proposed for the Boeuf River will carry. Yet the Chief of Engineers assumes that 900,000 sec.-ft. can be put down the valley of the Boeuf. No one knows the flow area, A, nor can anyone do more than guess at random what the flow velocity, v, will be. Official assumptions have been made as to the factor n in Kutter's formula for a cleared floodway and for the uncleared floodway; but the shades of Ganguillet and Kutter should rise in wrath at the attempt to extrapolate the data of their famous analysis to such huge values of Q as are now in question.

And this problematical flow is to be controlled and directed by "fuse-plug levees"! Where is the hydraulic engineer who until a few months ago had ever heard of the term? Hundreds of engineers have been unable to indicate its derivation; one is forced to the conclusion that an electrical engineer has strayed into the hydraulic engineer's bailiwick. When a fuse plug in an electric line blows out, the stream of electrical energy is stopped; when a fuse-plug levee blows out, it does not stop anything. Instead, it diverts water from the main stream, slowly at first but in gradually increasing quantity depending on a number of factors, such as character of levee material, height or levee and the get-away permitted by the terrain and its timber cover and back-water storage. Whereas the electrical fuse plug stops trouble in a very definite way, the hydraulic fuse plug merely starts a new kind of trouble in a small way, and only gradually and indefinitely effects its desired results. In the light of this comparison, the electrical engineer and his misleading term should be turned back from river hydraulics to his ohms and watts.

On the fuse-plug idea the administration plan depends very heavily. Giving it the most serious consideration, then, it must be said that never has a hydraulic engineer proposed such questionable safety devices; no overflows, spillways, safety valves or emergency outlets ever planned are of such indefinite capacity or effect as these fuse-plug

levees. The greatest crevasse of history—last year's break at Mounds Landing—passed less than 500,000 sec.-ft.; the three great Arkansas River crevasses, Pendleton, South Bend and Medford, are credited with less than 600,000 sec.-ft. combined. How can the much greater flow of 900,000 sec.-ft. ever be got through a fuse-plug section of the main levee near the mouth of Cypress Creek? And if this great flow of water should pass through the blown-out levee, how will it get away? No one can answer. There are no contour maps of the proposed floodway region, and less than a dozen cross-sections have been surveyed in a channel length of 150 miles—some of them are 40 miles apart!

If engineers were deliberately asked to provide a diversion plan on such meager data, the demand would be little less than insulting, and the resulting guesses could not even be classed as educated guesses. What's down the Boeuf Valley? More than 40,000 people and an immense gas-well field, potentially an oil-well field. Why the Boeuf rather than the Macon? Engineers along the river say both are probably needed. What little information is available concerning flow possibilities through the Tensas basin is not enough for the ablest engineers to guess at the effect of this or that overbank diversion. How much less can legislators be competent to decide on a plan? The Chief of Engineers and the Mississippi River Commission both worked from the same data, data all too meager for a dependable conclusion, according to all engineers who know the valley situation at all intimately. The commission has predicated all of its past plans on a "levees only" policy. Suddenly, within a brief time, it was forced to include spillways and diversions, and naturally these covered unknown physical territory.

As to levees: That levees alone are effective up to a certain point is admitted by everyone. At what point is their effectiveness limited? The question has not yet been finally answered. But it is known that with river training by means of revetment and other capacity-increasing measures, of which the commission's engineers are not ignorant, v in the formula may be speeded up and A may be enlarged, to accommodate the largest Q it is feasible to provide for.

Can the flood possibilities of all time be guarded against? No! As Col. Charles R. Potter, the president of the commission, testified before the flood-control committee of the House, the valley may as well know now that *100 per cent protection cannot be guaranteed nor attained.* Hydraulic calculations are not able to give such assurance. What the rainfall will be and where it will concentrate are a matter of forecast, of prophecy, and nothing else. The official maximum estimate—1927 flood plus 25 per cent—represents *nothing more than forecast.* Just 25 per cent in excess of the 1927 flood! Meteorologists can prognosticate how often a flood of that size will occur. And by the same methods of deduction they can prognosticate how often a larger flood, a flood 50 per cent greater than that of 1927, will occur.

It still remains for the engineers to figure the costs to take care of such a tremendous Q. But even when that is done, someone must figure against the cost the economic balance of benefits. Someone must say that the benefits are worth the cost, a thing that has not yet been done, since neither benefits nor costs are known. How essential, then, that all costs be figured! The administration plan does not pretent to do so.

When all costs are set up, no matter by what agency paid, and against them on the ledger are placed all of the benefits to be obtained, only then can the legislator say with some degree of rationality whether it is worth while and whether or not to go ahead. If the answer is "yes," then and then only is the time to say that we shall provide the money and create an organization to administer, design in detail and build the protective works. That organization should check over first what Q is to be taken care of, and provide by the most economical way sufficient A and v, first in the present channel, and thereafter out of the channel if necessary, always recalling that the bed of the river is the cheapest right-of-way.

Since no adequate plan and no estimate of total cost have been presented, present legislation should provide the means and organization and allow sufficient time for such a plan to be developed and its cost—its total cost—to be ascertained. Congressmen can then return to their legitimate functions of legislation, leaving engineering to engineers, who will make A and v commensurate with as large a Q as reasonably practical. In the meantime money should be provided for in a separate bill for work on the existing plan and for a more vigorous prosecution of revetment.

Gasoline Tax Questions

DECISION by the Illinois Supreme Court that the gasoline tax law enacted by the Legislature of 1926-27 is unconstitutional need not arouse concern as to the integrity of such laws elsewhere. Indeed, the decision commands high regard in but few of its aspects. There are behind it prenatal influences of political feudism, local-rights jealousies and supreme narrowness of concept and purpose in associated business. These influences do not escape observation in all that has gone on concerning a gas tax in Illinois from its conception to its court burial. At its broadest, however, the decision of invalidity rests on technicalities which have yet to be shown to have any force beyond the boundaries of the Illinois State Constitution. At least the federal Supreme Court has still to pronounce on whether the Illinois gas tax law "contravenes both the national and the state Constitutions."

But it is not the legality of the decision that chiefly concerns the Illinois road users. They have more to fear the local-rights jealousies which, when the gas-tax law was in the Legislature, made of it a mess of technical contradictions vulnerable to attack in the courts. There is no doubt that the motor-car users of Illinois were willing, as those of 45 other states have been willing, to bear the excise if the proceeds were to produce more roads and better roads. Nor was it their thought that the money coming from the tax should be spent for roads to the houses of those who paid it, but rather for building up a co-ordinated system of main and secondary highways on a state-wide plan.

It may be true that the law recently killed did not do this, that it was boggled in the making, that it did not conform to the technicalities of constitutional law. Then it should have been constructively amended. The cheer that is now being expressed at its death smacks more of satisfaction at having landed a shrewd blow on a political opponent than at having vindicated any principle of government.

The logic of things makes it certain that Illinois will have ultimately a gas tax. It is the way of financing roads that the people of all the states have most approved. The Supreme Court of Illinois has not changed this fact in any way.

Concrete Trestle Across Lake Pontchartrain

Plant and Methods Employed in Casting and Driving 2,796 Piles and Pouring 24,500 Lin.Ft. of Girder and Slab Deck for New Toll Bridge Entrance to New Orleans

A CONCRETE highway trestle 4.72 miles long across Lake Pontchartrain, Louisiana, was completed in 1927 at a speed not frequently exceeded even in straightforward concrete paving. At times a rate of a mile a month was attained. The structure consists of a concrete deck, with railings, in 35-ft. spans on capped four-pile bents, all heavily reinforced. Roughly there were 3 cu.yd. of concrete and 775 lb. of reinforcement per running foot.

Construction began officially Oct. 15, 1926. The contract time was 480 days to Feb. 15, 1928. Beginning to drive piles on March 18, 1927, 2,292 piles had been driven by Aug. 31 (104 piles a week), after which, the work being well ahead, no push for speed was made with the remaining 504 piles. Beginning to concrete the deck June 3, 2 miles was completed by Aug. 31 and the remainder by Nov. 30. In August a mile of deck (about 10,000 cu.yd.) was completed. Considering the character of the structure and the volumes of materials involved, these records of speed deserve notice as probably the highest ever made in concrete pile trestle construction.

Trestle Structure—The general design of the trestle is shown by Fig. 1 and the detail of the pile by Fig. 2. There is little in particular to be noted except the expansion and articulated joint arrangement and perhaps the lifting-bar reinforcement in the piles. Besides two steel draw spans, aggregating 427 ft. in length, with concrete abutments of regulation bascule type, the bridge consists of 700 spans of the standard trestle. With four piles to a bent, a total of 2,796 piles from 55 to 85 ft. long and averaging 74.45 ft. long were required. The deck railings aggregate 9½ miles and the piles totaled 208,162 lin.ft.

Summarizing the quantities to be handled, there were 30,500 cu.yd. of concrete in precast piles and 47,522 cu.yd. in pile caps, deck slab and railings. This concrete, using eight sacks of cement to the cubic yard, called for 144,286 bbl. of cement, 63,949 cu.yd. of stone and 41,240 cu.yd. of sand. The reinforcing steel aggregated 8,440 tons. Of these materials about half had to come into a receiving yard on shore, be transshipped to barges, be towed to the structure and be worked up on the job. The remainder of the materials, those for piles and railings, as well as the lumber for 1,500,000 sq.ft. of deck forms, had to be worked up in a shore plant and the finished product—cast piles and railing parts and fabricated forms—barged to the bridge. Conditions of construction then made necessary both a large materials-transfer and concrete-products plant on shore and a mobile field plant for a considerably larger on-the-structure output of concrete but drawing its materials mostly from the shore plant.

Location and Access—With the exacting requirements for the shore plant, location and access became important matters. As will be seen from Fig. 3, the location of the work was rather remarkably isolated despite the fact that a railway ran close by the new bridge. Virtually the whole terrain of the map is low and wet, a region of lakes, bayous and marsh land. Crossing this region, from settlement on the north represented by the town of Slidell, to New Orleans, are a railway and a highway. No other main ways of access from the outside were available except the waterways through New Orleans, and all materials had to come from the outside. In all the between-settlement area neither road nor railway gave

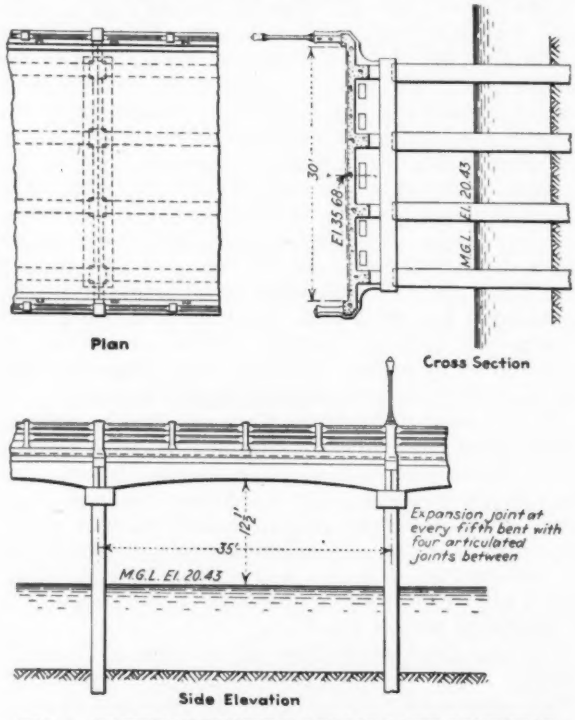


FIG. 1—HIGHWAY TRESTLE ACROSS LAKE PONTCHARTRAIN, LOUISIANA

There were 700 spans of this design and two bascule spans aggregating 427 ft., a total of 4.72 miles of viaduct.

any opportunity for a favorable take-off to a construction settlement at the bridge site, nor was the land suitable for camp and plant structures had connection been convenient.

Conditions then pointed to Slidell as the mobilizing center for the construction work. First, the town had railway facilities and it had markets and living places for a construction crew. A train service between town and bridge for workmen was practicable. Notably it had on Bayou Bonfuca a shipyard, with a channel, by way

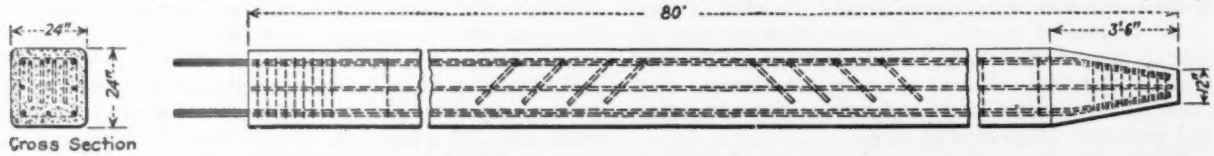


FIG. 2—PRECAST PILES FOR STANDARD TRESTLE

There were 2,796 piles averaging 75 ft. and 21 tons cast on shore and barged to the work.

of the bayou, to Lake Pontchartrain, and a portion of this shipyard fronting on the bayou could be secured for a plant site. To this site short sidings to the shipyard spur gave easy access for materials by train. From it the bayou gave a waterway to the lake and all the length of the new bridge for materials barges. Altogether a construction plant at Slidell seemed most logical, although it involved an average water haul of 12 miles to the bridge. It was laid out as shown by Fig. 4.

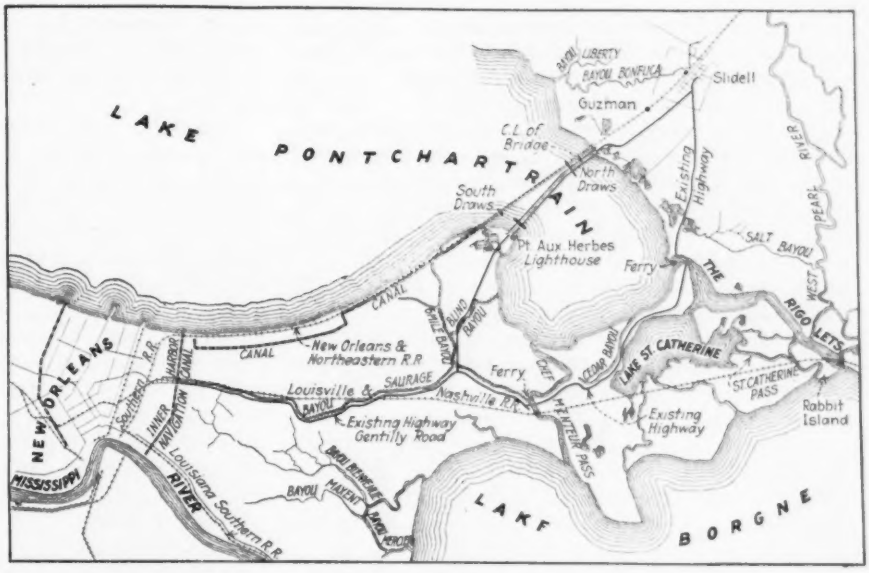


FIG. 3—LOCATION MAP OF TRESTLE, SHOWING TRANSPORTATION CONNECTIONS
A region of lakes, bayous and swamp rendered access difficult and made Slidell best location for mobilizing materials and plant.

Materials and Pile-Casting Plant — In laying out the plant several requirements had to be met. First, the plant had to be primarily a transfer plant. Materials coming in by railway, or by barge as was the case with cement, had (1) to be fabricated into structural units—piles, railing parts, form panels—and these then had to be transferred to barges and towed to the bridge or (2) to be stocked and then transferred to barges and towed to the bridge. Second, the plant had to be a storage plant. All raw materials, stone, sand, cement, reinforcing steel and lumber, had to be stocked to some extent, and precast piles and railing parts after their fabrication had to be stored a considerable time to gain strength for shipment and installation. Third, the plant had to be a sizable concrete-products and wood-working plant. Not including discards, 2,796 piles and parts for 9½ miles of railing had to be molded and cured. Panels had to be framed for 132 pile forms and for 1,500,000 sq.ft. of deck forms. Fourth, the volumes and loads to be handled called for large spaces and powerful equipment.

An end-on layout with respect to the waterfront was adopted, as shown by Fig. 4. The elements are four delivery tracks taking off from the shipyard spur and ending at the bayou; a parallel casting yard about 50 ft. to one side, and, between yard and tracks, a concrete plant and a railing casting platform. This parallel layout is further depicted by Fig. 6, which is a cross-section about at the mixing plant. On the bayou shore at the end of the delivery tracks is an elevated sand and stone bin; at the end of the concrete plant zone is a platform for receiving and delivering cement, and at the end of the casting yard is a dock for barges. The entire layout, it is to be noted, is predicated on the transfer function of the plant. This deserves emphasis a little in particular.

The delivery tracks provide (1) for stock piling and locomotive crane handling to the mixing hoppers for pile-casting work, and (2) stock piling and locomotive crane

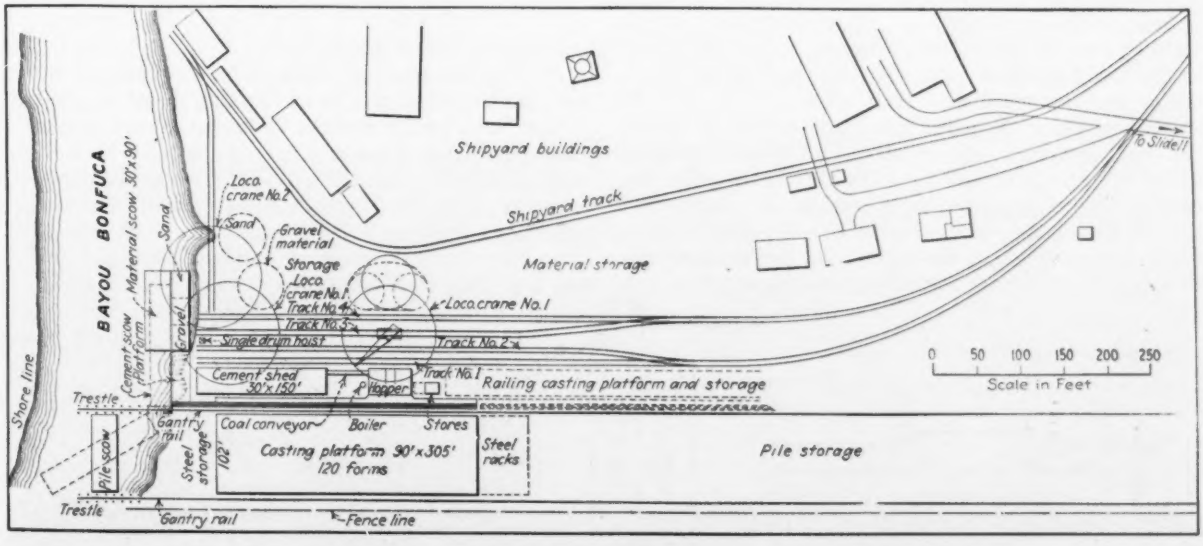


FIG. 4—MATERIALS-TRANSFER AND PILE-CASTING PLANT AT SLIDELL
Virtually all material for a 75,000-cu.yd. concrete structure came through this yard and was transshipped to barges after being unloaded and in part fabricated.

handling to the hoppers for loading barges. Again, the cement wharf location, with relation to the cement storehouse, permits receipt from barges (cement being the only considerable material received by water) or delivery to barges going to the bridge. Finally, the casting yard, with its long tail of pile-curing space, all covered by a gantry crane, terminates in a barge slip for transferring cast piles and reinforcing steel to barges going to the bridge. This transfer function thus stands out in each plant feature as well as in the plant general layout.

Particular description is required only of the pile-casting and pile-handling equipment. The land upon which the plant is built was partly swampy and the foundations of all plant structures had to be looked to rather especially. Wood piles were driven for the stone and sand

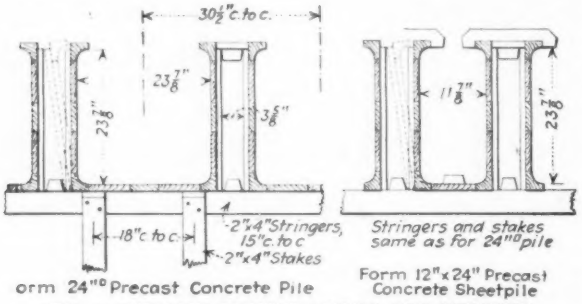


FIG. 5—DETAILS OF PILE FORMS AND MOLDING PLATFORM

bins and for the cement storehouse. Concrete spread footings carried the mixing plant and the 360-cu.yd. mixing-plant hoppers. Most particular attention was required by the pile-casting platform. This was supported on about 15,000 stakes 2x4 in.x6 ft., driven by maul on about 18-in. centers. Each stake was figured to carry 600 lb. Fig. 5 shows the platform and the forms for the piles, and Fig. 8 is a general view of the casting yard.

The pile molding called only for simple equipment. The mixing plant consisted of overhead bins, batchers and inundators and of two 1-yd. mixers. The concrete was wheeled to the pile molds on runways shown in Fig. 8. There were 132 of these. The piles were left in the molds seven days, were kept wet 30 days and were kept in storage 53 days altogether. Pile handling and not pile molding was the controlling operation. After seven days in the forms the piles had to be lifted and carried to the curing and storage area. Then after not less than 53 days they had to be lifted again and carried to barges for transportation to the bridge. With piles a maximum of 85 ft. long and containing 340 cu.ft., straight-forward carriage was an important consideration. It was obtained by adopting a long narrow yard between gantry crane tracks and heading onto the water front and using successive zones of this space for a barge-loading slip, for storing reinforcement, for molding piles, for assembling reinforcement and for curing and storing piles. Figs. 4 and 8 indicate the yard arrangement and the gantry crane service.

Specifically a crane span of 102 ft. was adopted and the crane run was made 1,500 ft. This gave room for a 90-ft. molding platform and ample clearance for the longest piles and reinforcing bars when being carried. Carriage, it will be observed, was always in a direct straight line and always clear of whatever working operation was in progress in any zone of the yard. The crane was gear driven and had a rated capacity of 25 tons. Like the mixers, it was steam operated. Primarily the crane was a cast-pile carrying device. It also had to carry piles only seven days old. Fig. 8 shows a pile being carried, at three lifting points. A system of blocks and falls attached to the main hoisting fall, is connected with the lifters so as to exert an equally distributed lifting force.

Transfer between yard and barge other than by the gantry crane consisted chiefly of cement and aggregates. Cement came in unbroken barge lots of 10,000 bags from the mills at Spocari, Ala. That for the deck concrete was, as much as could be, delivered directly to the floating mixing plants. The reserve cement for the floating plants and all cement for piles and railing castings were unloaded into a 24,000-bag cement house. For transferring aggregates, overhead bins chuted to barges. These bins had 600-cu.yd. capacity and were loaded from stock piles by two locomotive cranes, with 1½-cu.yd. buckets. The sand and stone came in by train and the two cranes unloaded twenty cars a day into stock and bins. The bins could chute a barge load of 200 cu.yd. in 40 minutes.

The materials-transfer and pile-casting plant capacity is measurable only by the maximum output figures given. For about 26 weeks, as stated, 104 piles a week were driven. This called for the casting of at least that number a week. As a matter of fact, for weeks, using 132 forms, 125 piles a week was the regular schedule of production. In constructing 2 miles of deck in the period of about twelve weeks from June 3 to Aug. 13, cement, sand and stone and reinforcement had to be transferred for about 20,000 cu.yd. of concrete. In August, when a mile of deck was built, materials for 10,000 cu.yd. of concrete had to be transferred.

Floating Construction Plant—These top outputs called for a floating plant capable of handling them. A schedule of the floating units includes 36 barges, eleven towboats, three piledrivers (two concrete, one wood), three concrete plants and one derrick. Taking the allotment of barges on a day in August, the most active construction month, seventeen were handling forms, eight were handling concrete piles, six were handling sand and gravel and five were handling cement, wood piles, steel, pipe

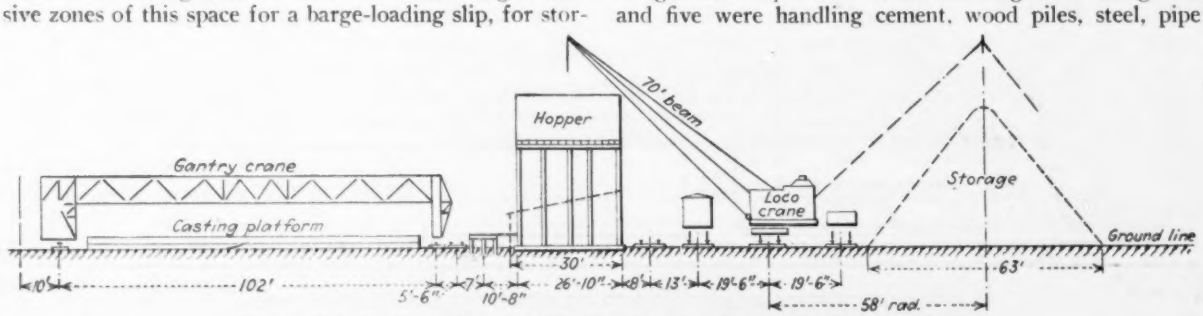


FIG. 6—SECTION ACROSS TRANSFER PLANT ABOUT AT MIXING PLANT
Note the parallel three-unit arrangement shown by the plan

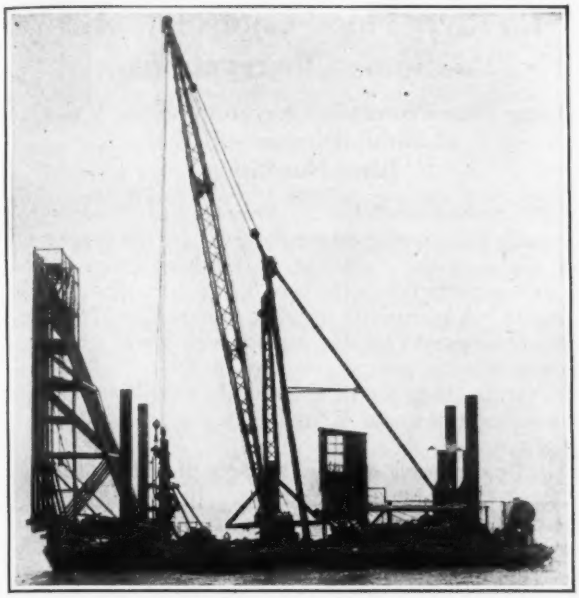


FIG. 7—FOUR-LEAD, PILE-DRIVER BARGE WITH PILE-HANDLING CRANE

and oil. On this day five towboats were handling barges and six were at other work. These allocations of barges and towboats changed with the work, as did those of other floating plant units, and the main purpose of the schedule given is to indicate the volume and variety of floating plant. The constructing units were the pile-drivers and the concreting plants; all others were servicing units.

Two piledrivers drove all the piles. One of them was a multiple driver of the construction shown by Fig. 7 and one had single leads. The multiple driver put down four piles—a full bent without moving. Then it was pulled back by a stern anchor line the length of a span and lined up in driving position by tape and instrument. When spotted, the spuds were dropped and the boat "set up" on them. Then the two outside piles were swung into the leads by the 40-ton derrick and lowered. Final adjustment of the leads was then made by three screw-feed engines, the leads sliding fore and aft on greased plates and athwartship on rollers. The specifications required a final pile alignment within 1 in. Commonly it varied not more than $\frac{1}{4}$ in. With the leads adjusted, the two inside piles were set and the derrick swung the two hammers onto the outside piles. When these were down, the hammers were changed to the inside piles. The driver barges were 40x100x8 ft. Two boilers, aggregating 180 hp., supplied steam. The equipment arrangement is clearly indicated by Fig. 7 and Fig. 9.

For deck construction the main equipment units were three floating concrete plants and two small derricks traveling on the forms. The big mixing plant used in pouring the deck consisted of overhead bins, two 1-yd. mixers, batchers, inundators, a 65-ft. mast hoist and chutes. Two $\frac{1}{2}$-yd. mixing plants poured caps, curb and posts for precast railing. The small derricks on the forms unloaded the reinforcement, placed falsework and handled forms for resetting. The sand, cement and stone were unloaded by derricks and the cement was transferred to the mixer by a conveyor. When set up for concreting, the cement barge was moored astern and the sand and stone barges alongside the mixer barge. Water was obtained by sinking 4-in. wells along the line of the trestle and pumping to pipe lines strung along the work. The important detail of the concreting was the co-ordination of operations; procedure and control followed ordinary good practice. The inspection was close.

In all the field construction the big problem was co-ordination. This was sought by laying out sequences and schedules as precisely as possible but in a more important way by so closely and consistently exercising superintendence that breaks in sequence and time were concentrated on and filled in before setback of general progress occurred. Division of work was first carefully set up. Thus separate gangs working in order (1) drove piles, (2) set yokes on piles for cap forms, (3) set cap forms, (4) set cap reinforcement, (5) concreted caps, (6) stripped cap forms, (7) carried cap forms ahead, (8) stripped and set falsework, (9) set deck forms, (10) set deck reinforcement, (11) concreted deck, (12) stripped deck forms, (13) carried deck forms ahead. At times the subdivision was increased and at other times decreased. Following division of work, performance

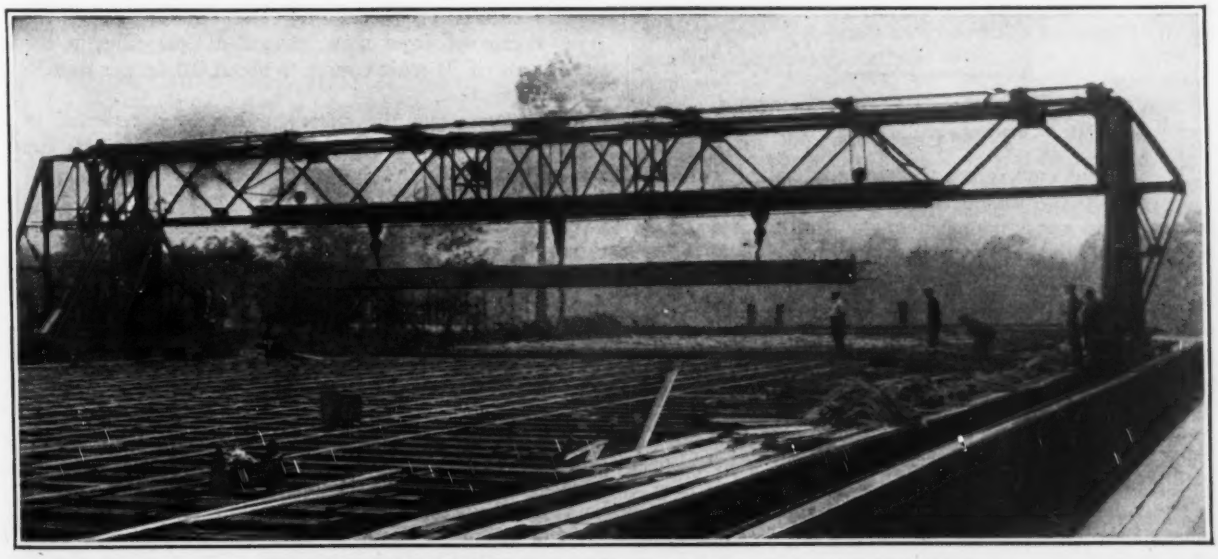


FIG. 8—GENERAL VIEW OF PILE-CASTING YARD AND GANTRY CRANE

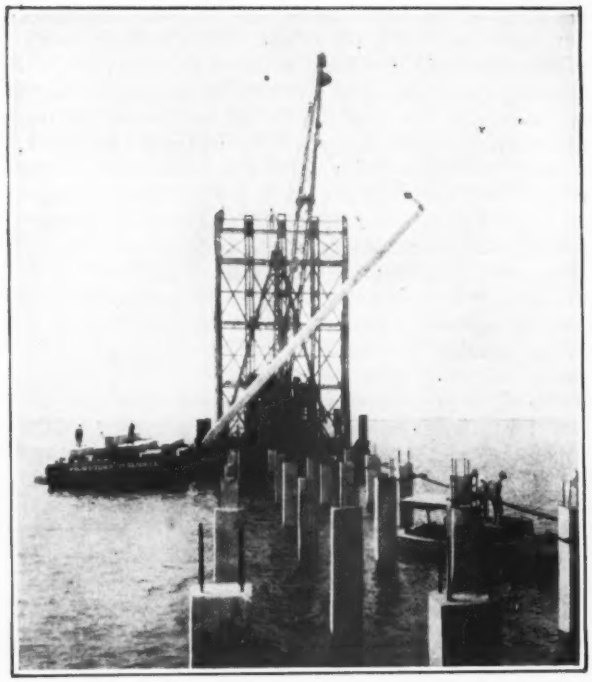


FIG. 9—FRONT VIEW OF FOUR-LEAD PILE DRIVER
This driver put down one four-pile bent without moving.

stints were established. From these, sequences and schedules were laid down for servicing operations. In brief, division of work, sequence of operations, time schedules and performance stints were carefully planned and kept flexible by close superintendence. This comprised the whole means and method of attaining the speeds and progress recorded. Form construction, placing reinforcement and pouring concrete all kept to usual procedure.

Design and Supervision—The Pontchartrain bridge is a toll-road project which includes, besides the 4.72 mile trestle, about 10.66 miles of approach roads, making a total of 15.38 miles of new construction. This new line is 9 miles shorter than the existing road, which also has the hindrance to traffic of two ferries. Both routes are shown on the map Fig. 3. The trestle was designed by Ford, Bacon & Davis, New York, and was constructed by the Raymond Concrete Pile Company, New York.

Tentative Railroad Valuation Work Now Complete

The task of completing the tentative valuation of the railway property of the country has been completed, according to an announcement by Frederick H. Lee, secretary of the President's conference committee on federal valuation of the railroads in the United States. By June 30 the commission expects to have issued a final valuation in nearly all cases.

As of Dec. 31, 1927, the commission had served a total of 1,076 valuation reports, of which 615 have become final by decision and order. These 1,076 final and tentative reports cover 1,726 corporations, or 242,779 miles of road, which is the total amount of railroad mileage under valuation.

The work of placing a valuation on the railway properties of the United States has been going on since 1913, when the valuation act was passed.

Po River Flood-Control Works —Some Observations

Long-Time Protective Operations Show Value of Multiple Levees—Bed of River Not Rising

LAST September John R. Freeman, of Providence, made an extended inspection trip over the flood-control works of the Po River, in northern Italy, where regulating operations have been in progress for several centuries. A manuscript monograph reporting Mr. Freeman's observations on this trip contains a series of conclusions that are reproduced here in substantially complete form. They are of value in their possible bearing on river control in the United States, especially that of the Mississippi.

The Po drains one-third of the area of Italy and is the country's most important stream. It flows eastward through the plains of Lombardy from the vicinity of Turin to the Adriatic about 30 miles south of Venice. Its tributaries drain the southern slopes of the Alps and the northern slopes of the Apennines; they are largely of steep slope until they reach the floor of the main valley. The river is about 300 miles long east to west (425 miles along the river course). It carries much sediment, of which the finer fraction is carried to the mouth and builds out the delta. Records of shore lines covering a period of 200 years indicate a total extension of the river mouth of 15 to 20 miles out into the Adriatic within the time of history. The oldest ("Etruscan") shore line, which passes near Ferrara, is marked by a line of sand dunes, but those of subsequent periods are not thus evident on the ground. Extension of the delta during recent centuries has gone on at the rate of nearly ½ square mile per year; the present increase is about 160 acres per year, but a century ago it was 530 acres per year.

Annual rainfall on the drainage area (27,500 square miles) is about 42 in. The total annual runoff ranges from 52 to 68 per cent of the rainfall. The maximum flood discharge was 300,000 sec.-ft. in 1917 and even greater in 1926, when a flood beyond all prior records occurred and there were numerous levee breaks in the middle section of the river. The flood slope of the river decreases from more than 2 ft. per mile in the upper part of its main course to about 0.6 ft. per mile in the delta section.

For many years the statement has been repeated in river literature that sediment deposits have raised the bed of the Po above the level of the surrounding bottom lands. Mr. Freeman finds that this is not the case, although a smaller neighboring stream, the Adige, has thus raised its bed. Maximum flood elevations of the Po have increased in the course of time, however, probably due to more complete confinement by levees. Work is now in progress on a general program of raising the levees 1 m. (3.3 ft.) along the lower river in view of the unprecedented flood stage of 1926.

The Po and its torrential tributaries have been a source of flood trouble from time immemorial, and the tributaries have long been leveed. Delta cones have formed where these tributaries debouch on the valley floor, and here their beds have been raised.

After the great flood of 1917 elaborate efforts were begun to collect hydrographic data. The number of rain

gages in the basin was increased to nearly 917 (one for every 30 square miles), the river gages to 137 and discharge gaging stations to 66. In addition, 123 stations for measuring ground-water level were established.

The topography and hydraulics of the Po Valley are affected by a progressive earth tilt downward to the east. At Ravenna and at Venice structures known to have been above water some centuries ago are now below water.

Levees at many points are as much as 25 ft. high, at some points even considerably higher. Top widths are 16 to 23 ft., and the crest is utilized for a road. The traffic on this road helps to keep muskrats away. Waterside slopes are 1 on 1½, landside slopes 1 on 2, usually with a berm or banquette at midheight and sometimes another near the foot. The levee material generally is fine sand, and both in this respect and in foundation soil the Po Valley presents more favorable conditions than that of the Mississippi. In the region of highest flood stages there are two parallel lines of main levees, the rear one providing a second line of defence. Elsewhere a network of road embankments gives equivalent secondary protection. In many sections a further but lower dike has been built along the river bank to permit agricultural use of the flood land inside the main levees in all years but those of high floods.

At intervals of a few miles large brick storehouses for sandbags are maintained, for use in flood emergencies. The valley population is fully organized for flood-protection work, and thousands of men can be mobilized for levee topping and slope-protection work. A thorough system of flood forecasting and telegraphic warning has been established.

Narrowing the river in the reaches between bends has been effective in preventing the formation of crossover bars and reducing dredging.

Two Sewers Built Simultaneously to Opposite Grades

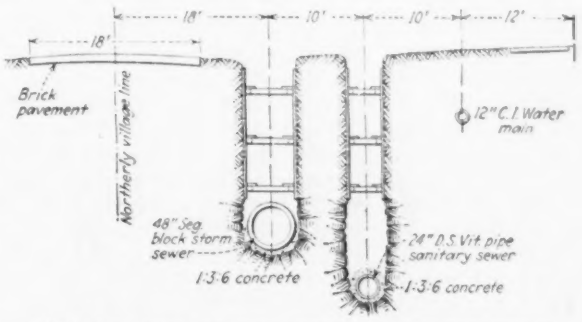
Parallel Trenches Dug at Same Time With Duplicate Outfits for Separate Sewers Flowing Opposite Ways

By I. M. Baker
C. W. Courtney Organization, Engineers, Cleveland, Ohio

IN DEVELOPING the sewerage of Beachwood village, in suburban Cleveland, it has been necessary, to meet local outlet requirements, to build separate sewers on Cedar Road, one to carry the sanitary sewage west and the other to carry the storm water east. The requirement of opposite grades made two trenches necessary, and as the two sewers were parts of one drainage unit, one contract was awarded to build both conduits at the same time. Cedar Road being the main traveled road out of Cleveland to Youngstown and the traffic on it being heavy, it was also necessary to keep all machinery and materials off the 18-ft. pavement.

To separate the trenches as far as possible and not interfere with the pavement and an existing 12-in. water main, the two sewers were kept 10 ft. on centers, which placed the sanitary sewer 10 ft. from the water main and the storm sewer 9 ft. from the pavement. To prevent the water main from sliding into the lower trench and the pavement from dropping, the trenches were sheeted and all sheeting was left in place. The accompanying illustration shows the arrangement. As indicated, the sanitary sewer was laid in a ring of concrete and the invert of the storm sewer was cradled in a bed of concrete up to the springing line. All concrete was mixed in portable batch mixers, as it was needed for immediate use.

The E. P. Langenhan Construction Company received the contract and work was begun in November, 1927. Segmental block was selected for the 48-in. storm sewer, as this material was available for immediate delivery.



PARALLEL SEWERS WITH OPPOSITE GRADES BUILT SIMULTANEOUSLY

The contractor started work at a culvert over Euclid Creek and progressed westerly, working on both sewers simultaneously, keeping the sanitary sewer a few hundred feet ahead of the storm sewer. In doing this the sanitary sewer was laid down grade, just the opposite of the usual procedure. A temporary connection was made between the sewer and the culvert to act as an overflow. At the first manhole the sewer was bulkheaded so that only a small amount of water had to be pumped at the point of pipe laying. Some difficulty was encountered at intersecting streets, where lateral sewers had already been constructed. These laterals were filled with water, which had to be drained through the completed storm sewer to the culvert before the junction manholes could be built.

The excavation for a depth of about 15 ft. was clay and was removed by a steam shovel and the trench tight sheeted, using three rows of cheeks and braces. Below this depth soapstone, shale and a thin layer of hard bluestone were encountered. This hard material was loosened with dynamite and removed by a crane equipped with a clamshell bucket. A portable air compressor operating pneumatic drills prepared the holes for the necessary blasting. The storm sewer being about 20 ft. deep, it was necessary to have the same amount of equipment for its construction. On each job there was also a ½-yd. concrete mixer. The bituminous jointing compound was heated in a small kettle, which was moved often so as to be near the place of pipe laying.

$5,000,000 Road-Building Program Planned by Japan

A comprehensive plan for road improvement and construction for the whole of Japan proper which contemplates the expenditure of about $5,689,000 over the next ten years has been formulated by the Civil Engineering Bureau of the Home Department. The program will extend over 3,600 miles of road. Municipalities, prefectures and the national government are reported aroused to the necessity for providing for increased automobile traffic.

Wind-Pressure Tests Made on Large Model Building

Results Indicate Older Formulas Are Too High—Framework May Offer Greater Resistance Than Covered Building—Effect of Open Windows

By E. R. DAWLEY
Associate Professor Applied Mechanics, Kansas State Agricultural College, Manhattan, Kan.

PRESENT formulas for wind pressure are the results of tests in which small model buildings are subjected to an artificial wind. Such wind tunnel tests on small models sometimes give misleading results, and it has been found that the larger the model the less the error. This article gives the results of a series of wind tunnel tests on a model building which is, so far as the writer has been able to discover, the largest model building ever tested. Tests were made as follows, placing the building in both crosswise and endwise positions in the wind tunnel: (1) Framework only; (2) building covered, and with doors and windows closed; (3) building covered, but with doors and windows removed. The wind tunnel used was 50 ft. long and had a cross-sectional area of 143 sq.ft. at the test section (10 ft. 6 in. x 13 ft. 8 in.). It is believed to be the largest in existence.

Dimensions of the model building are shown in Fig. 1, and Fig. 2 shows the framework and covering used. Originally the building was meant to represent a model garage, hence the large door in one end. Otherwise it is typical of a small dwelling, and only when the large door was open would this analogy fall down. Beaver board was used to cover the walls and roof. The ends and sides of the beaver board after it was tacked on were flush with the framework, probably giving better aërodynamic properties than are obtained in average construction. Strips of drawing paper were glued to the roof hip joints to make them air tight.

Platform Resistance—Before it was possible to arrive at a quantitative value of the wind resistance of the framework, it was necessary to determine the magnitude of the resistance of the wind tunnel platform. A test was run with nothing in the wind tunnel, and it was found that the platform resistance under this condition was too small to be measured—practically zero. From Zahm's experiments quoted by J. C. Hunsaker in Marks' "Mechanical Engineers' Handbook," this resistance in pounds would be: $R = 0.00000778b\ L^{0.93}\ v^{1.86}$ where R is the resistance for the upper exposed surface of the platform, b is the width of the platform, L the length of the platform and v the air velocity in feet per second. At 40 m.p.h., the value of R may be shown to be less

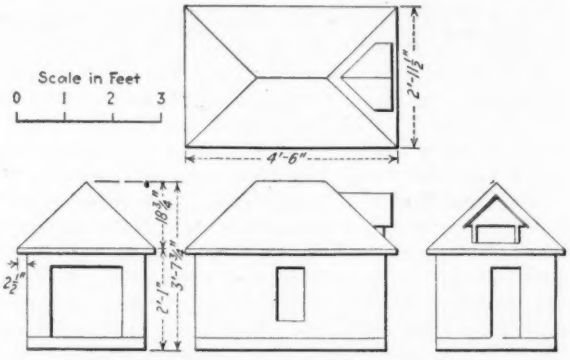


FIG. 1—DETAILS OF MODEL BUILDING

than half a pound. There remained, however, the possibility that the platform resistance might be increased by the presence of the building itself. Accordingly another test was run, this time with the building suspended from the roof by wires so that it just cleared the platform. The suspicion proved to have been well founded, since the platform resistance determined in this manner proved to be nearly 1½ lb. at 40 m.p.h. The platform resistance was subtracted from the gross pull in every case.

Framework Tests—The first actual test was made with the framework of the building crosswise of the air stream and centrally located on the platform; fifteen observations were made with the building in this position. The framework was then placed lengthwise of the tunnel with the dormer heading into the wind; eighteen observations were made in this position. The results of these two tests are shown as the two lower curves in *a*, Fig. 3. The plotted points are the actual observed values after reduction to standard atmosphere and correction for platform resistance. In view of the fact

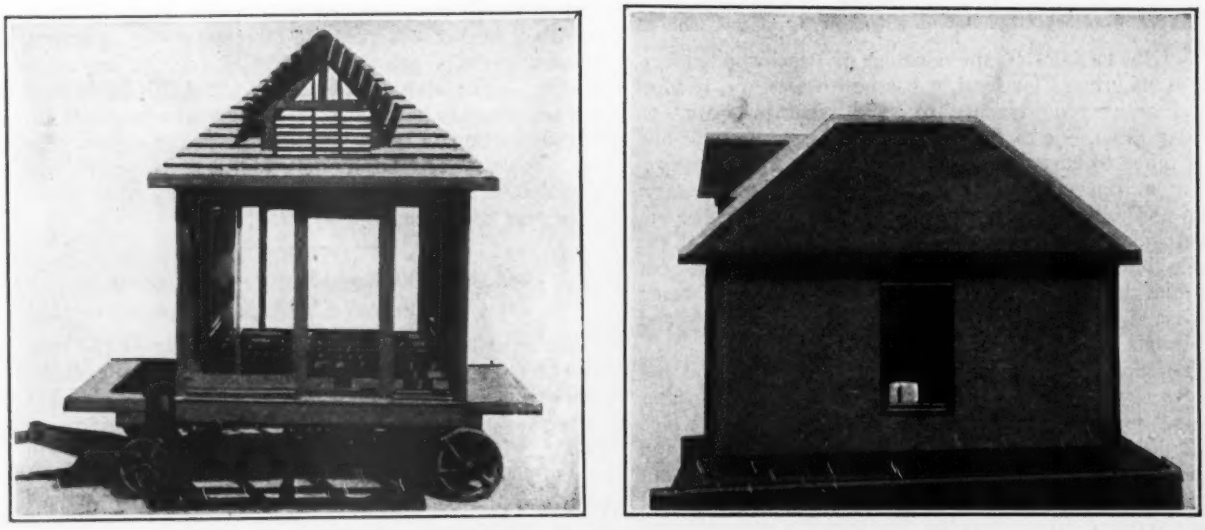


FIG. 2—END VIEW OF FRAMEWORK AND SIDE VIEW OF COVERED MODEL

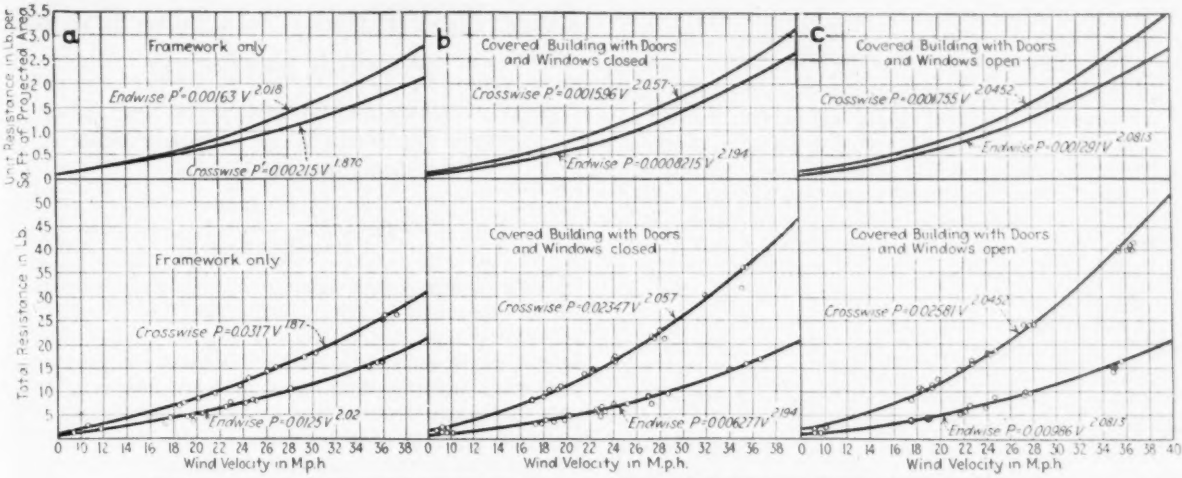

a
Framework only
Endwise P'=0.00163 V 2.018
Crosswise P'=0.00215 V 1.870
b
Covered Building with Doors and Windows closed
Crosswise P'=0.001596 V 2.057
Endwise P'=0.0008215 V 2.194
c
Covered Building with Doors and Windows open
Crosswise P'=0.001755 V 2.0452
Endwise P'=0.001291 V 2.0813
Unit Resistance in Lb. per Sq. Ft. of Projected Area
Framework only
Crosswise P=0.0317 V 1.87
Endwise P=0.0125 V 2.02
Covered Building with Doors and Windows closed
Crosswise P=0.02347 V 2.057
Endwise P=0.006277 V 2.194
Covered Building with Doors and Windows open
Crosswise P=0.02581 V 2.045
Endwise P=0.00986 V 2.0813
Total Resistance in Lb.
Wind Velocity in M.p.h.
Wind Velocity in M.p.h.
Wind Velocity in M.p.h.

FIG. 3—TOTAL AND UNIT PRESSURES ON MODEL BUILDING IN WIND TUNNEL TESTS
Tests were made on the framework and on the covered model with doors and windows both open and closed

that none of the original data were discarded, the consistency of these points is noteworthy. The equations shown are the equations of the curves of best fit for the data as determined by the method of averages.

When it is desirable to compare the wind resistances of several geometrically similar objects, it is convenient to compare their unit resistances in terms of pounds per square foot of projected area. Accordingly the unit resistance of the building in each position and test condition has been computed for the projected area of the *completed building.* The two upper curves in *a,* Fig. 3, show the unit resistance for the building framework in each position. The ordinates for these curves were obtained by dividing the ordinates of the two lower curves in *a,* Fig. 3, by 7.64 sq.ft. for the end projection and 14.71 sq.ft. for the side projection (see Fig. 1). By comparing the two sets of curves in *a,* Fig. 3, it will be noted that whereas the total pressure is higher for the crosswise position, the pressure per square foot is higher in the endwise position. This is no doubt due to the greater eddying or turbulence produced in the endwise position. This was the only case where such a condition was obtained.

Covered Model, Doors and Windows Closed—In *b,* Fig. 3, diagrams show the results of the tests on the model after the covering was attached, doors and windows being closed. The total pressures are plotted as the two lower curves and the unit pressures as the upper curves. Here we have the crosswise curve higher than the other, no doubt because of the poorer aërodynamic properties in this position.

Covered Model, Doors and Windows Open—The highest values of wind pressure were obtained in tests with doors and windows open (or, rather, removed). The results are given in *c,* Fig. 3.

Discussion of Results—In order to simplify the comparison of the unit wind pressures under the various test conditions, the curves of Fig. 4 have been prepared, showing the three endwise tests and the three crosswise tests. These curves show that the three different test conditions caused little difference in the unit resistances in the endwise position, but caused considerable difference in the crosswise position.

For the endwise position it is perhaps worth noting that the framework alone had the highest pressure. This means that it is possible for a greater wind load to come on a partly completed structure than can ever come on the completed structure, with the same wind velocity. The effect of opening doors and windows is not very marked in the endwise position, but gives somewhat higher resistance than when the building is tightly closed.

The most striking fact shown in the curves for the crosswise position is the rate of divergence of the two upper curves, showing the effect of having the doors and windows open. The curve for the framework resistance, although it is lower than the two others, is still nearly two-thirds of their average value and is considerably higher than would be suspected after looking at Fig. 3.

The failure of the Meyer-Kiser Building during the recent Florida hurricane (*Engineering News-Record,* Oct. 14, 1926, p. 624) appears to verify the before-mentioned facts. After the first blow the wind was admitted through many apertures. Whereas other structures of similar construction suffered comparatively little damage, the Meyer-Kiser Building's walls were cracked or blown out and the steel framework was racked and permanently bent. Calculations based on the bending of the upper story of the roof tower indicate an effective wind force of 55 to 65 lb. per sq.ft. The Weather Bureau gave 132

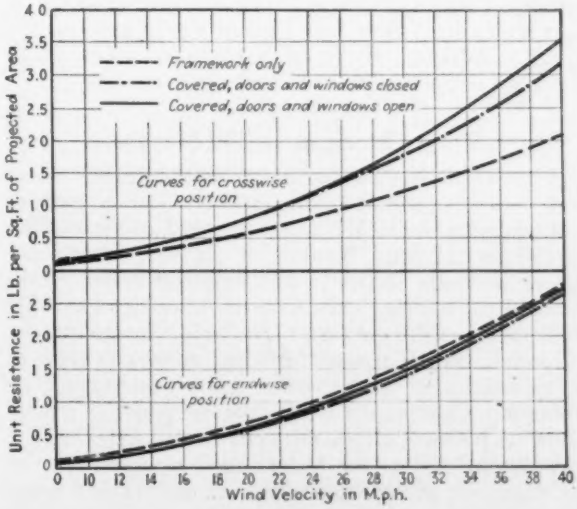

Framework only
Covered, doors and windows closed
Covered, doors and windows open
Curves for crosswise position
Curves for endwise position
Unit Resistance in Lb. per Sq. Ft. of Projected Area
Wind Velocity in M.p.h.

FIG. 4—COMPARISON OF RESULTS UNDER DIFFERENT TEST CONDITIONS

m.p.h. as the actual maximum velocity and computed the pressure on a flat surface normal to the wind to be 57 lb. per sq.ft., using the formula $P = 0.0033\ V^2$. A building, however, is never a flat surface normal to the wind.

The results of this wind tunnel test, when extended for a wind velocity of 125 m.p.h., are interesting even though such a procedure is unwarranted, in view of the fact that none of the original measurements was made above 40 m.p.h. The maxumum unit pressure becomes 34.11 lb. per sq.ft. of projected area when the value $V = 125$ is substituted in the upper equation given in *c*, Fig. 3, for the covered building in crosswise position with the doors and windows open. Reducing this equation to the equivalent square at 35 m.p.h., we have $P = 0.00206\ V^2$, whereas the Weather Bureau uses $P = 0.0033\ V^2$. The difference in action between a building and a flat plate can easily account for this discrepancy.

Conclusions—In this investigation, and also in the investigation of wind resistance of automobiles conducted at the Kansas State Agricultural College, the wind pressure was found to vary with a power of the velocity slightly higher than the square. The exact formula for the maximum pressure from this experiment is $P = 0.00176\ V^{2.05}$, or as a square equation $P = 0.0022\ V^2$ at 125 m.p.h. Many of the other formulas, such as that of Rankine and Smeaton, are two or more times too high. Newton alone came close to this, with $P = 0.0024\ V^2$ for the pressure on a flat plate.

Window shutters that can be securely fastened are to be recommended for localities subject to hurricanes or even tornados. The débris carried by the wind in such storms always breaks the glass windows and not only exposes the interior to the destructive action of the elements but also actually increases the forces tending to wreck the building. For garages and other light buildings, which are sometimes bodily carried away, anchor bolts for both the roof and the walls are to be recommended.

Building frameworks and towers in the preliminary stages of construction at a given wind velocity may be subjected to wind stresses in excess of those possible after the building is completed. Hence greater care in the provisions of windbracing during construction is recommended.

Modern engineering practice designs structures to withstand lateral pressures of 20 to 30 lb. per sq.ft. It appears to the writer that without undue expense this could be increased say to 35 lb. per sq.ft., which would probably insure against a 125-mile gale.

What Chlorination Will Not Do

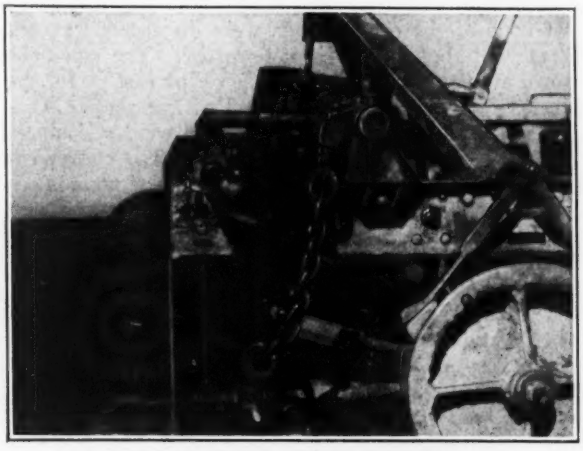
After reviewing the usefulness of chlorine in water and sewage treatment and as a deodorizer at garbage and rendering works, William J. Orchard, of the Wallace & Tiernan Company, Newark, N. J., in a recent paper before the Texas Section of the Southwest Water Works Association, sounded some notes of warning as to what chlorination will not do. He said, in substance: "Chlorine will not remove turbidity, or enough color to be appreciable, or mud and dirt and organic matter, or pollution. Chlorination won't take the place of a filter plant. A polluted, turbid, dirty chlorinated water supply, however satisfactory the bacteriologist may find it from the standpoint of total counts and coli content, will never be acceptable to the consumer, will never satisfy his desire for a clear, sparkling, safe glass of water."

Concrete-Finishing Machine Spreads Asphalt Surfacing

Better Surface and Greater Speed Secured on Black Top Road Work by Substituting Machines for Rakers

By Guy H. James
Resident Engineer, State Highway Department, Holdinville, Okla.

THAT there is need of improving the finish of asphalt pavements is generally acknowledged. With competent and rigid control of the mix the stability of an asphalt pavement can be assured. Overcoming the tendency to instability will not, however, insure a satisfactory pavement unless the structure is first built with a smooth surface. The most recent improvement in this direction is the use of machine finishing with the standard concrete-road finisher. An example of its work on



FINISHING MACHINE ROLLING BACK ASPHALT

6½ miles of road in Oklahoma is given here. The work was part of an 8.2-mile federal-aid project, which called for 1½ in. of rock asphalt on a 5-in. concrete base, without a binder course.

Base Construction—Concreting the base, which is a modified Bates section, 1:3:5 mix, with a 9-in. edge thickness, including a 1½x9-in. curb, was begun Sept. 7, and was completed Nov. 16, 1927, maintaining an average production of 1,750 sq.yd. per day's run. The base was checked with a 10-ft. straight-edge after finishing with a screed-type machine followed by 5-ft. hand floats, and all variations of more than ¼ in. were corrected. After the concrete had taken its initial set, it was roughened by raking lightly to improve the bond with the top.

Asphalt Surfacing—The asphalt surface, under the Oklahoma specifications, is a modified Topeka mix, which is delivered to the street at a temperature of from 250 to 350 deg. F., using a native rock asphalt for coarse aggregate. For the first 2 miles the surface was laid by the usual method of spreading by shovels to an approximate grade, after which the smoothing operation was accomplished by raking, followed by two 8-ton rollers for compression. After the initial rolling, the surface was checked with a 10-ft. straight-edge, and any variation of more than ¼ in. was corrected by patching. Due to the difficulty in securing competent rakers, this patching operation was almost continuous.

After many unsuccessful efforts to overcome the difficulty, it was decided to try the road-finishing machine used on the concrete base as an experiment to determine whether or not a more uniformly smooth surface could be secured. A few changes in the machine were necessary. The wheels had to be set nearer the frame so they would ride the edge of the curb on the concrete base instead of on metal forms set with 18-ft. clear spacing, and the screed had to be raised by an amount experimentally determined to be necessary for a 1½-in. compacted thickness. An attempt was made to use the tamper and an improvised metal belt behind, but they were later abandoned because no good was accomplished by either. To prevent adhesion of the asphalt, the screed was heated with a large gasoline torch before starting in the morning and at other times when the delivery of material was interrupted. When operating continuously it did not need heating. Probably no heating would be required in hot weather operation, but since the temperature ranged between 32 and 70 deg. during the test, it was necessary to start with the screed hot to keep it clean.

In operation, machine finishing develops some sharp differences from hand methods. It demands much less care on the part of the shovelers, since the only requirement is that they keep the material banked against the screed throughout its length, without attempting to maintain a grade. The kneading action of the screed tends to equalize the density of the material on all areas crossed, leaving a surface ahead of the roller already partly compressed, and, what is more important, equally compressed.

Examination of the asphalt behind the finisher and behind rakers showed the superiority of the former. Testing the rolled surface behind the finisher with a 10-ft. straight-edge showed few variations of as much as ¼ in., the maximum allowed by the specifications. Thus patching was practically eliminated and with it the attendant delay to the rollers and additional labor expense. Specific gravity tests on samples cut from both the hand- and machine-finished road showed an average of 2.16 for the former and 2.17 for the latter.

An important factor contributing to the superior riding qualities secured by the new method was the speed with which the machine operation was completed, which, with the necessity for patching removed, allowed the roller to follow immediately, before the bituminous top had cooled. It was soon discovered that the material could be delivered to the road at a temperature near the lower limit of the specifications and that the rolling could be completed with the materials still at proper heat; previously a higher temperature had been required. Sufficient reduction in heat at the mixer was effected to react favorably in increased plant output.

Increased Production—A comparison of the yardage actually laid shows that on the first 2 miles the contractor lost more than 3 per cent in materials overrun, whereas on the 6.2 miles machine laid this loss was reduced to 0.16 per cent, with very marked reduction in the daily variation.

The installation of the finisher was at once reflected in increased production. The asphalt-mixing plant used had a capacity of 45 batches of 1,275 lb. per hour, which is sufficient to lay 382 sq.yd. per hour using 150 lb. per square yard. The rakers were never able to finish this amount and therefore the plant production was limited to the capacity of the street crew. This ranged from a minimum daily average of 39 per cent to a maximum of 75 per cent of the plant capacity, and amounted to an average of 218 sq.yd. per hour. The machine, on the other hand, could maintain a rate of 7½ ft. per minute, or 450 ft. per hour, spreading 825 sq.yd. per hour. Thus it will be seen that the capacity of the street crew was increased to more than twice the possible plant production. The hourly output averaged 334 sq.yd., or an efficiency of 87 per cent. Time studies showed that the daily efficiency attained on the last 6.2 miles laid ranged from 75 per cent to 97 per cent of the plant capacity, making the plant output the governing factor in production instead of the street crew.

Comparative Costs—Much can be said for the use of the new method from the standpoint of economy, as a comparison of the actual labor cost, using each method, will show. This comparison is given in the accompanying table.

COMPARISON OF LABOR COSTS

Asphalt Plant Labor

Kind of Service	Number of Men	Rate Per Hour	Total Per Hour
Foreman	1	$1.10	$1.10
Receiving and loading materials:			
Crane operator	1	1.00	1.00
Measuring device operators	2	0.40	0.80
Mixing:			
Mixer man	1	0.75	0.75
Handling materials, dust and asphalt	4	0.40	1.60
Oiler	1	0.50	0.50
Boiler foreman	2	0.65	1.30
Gas heater fireman	1	0.65	0.65
Total			$7.70

Hand-Raking Crew

Foreman	1	$1.00	$1.00
Rakers (one patching)	5	0.75	3.75
Shovelers	6	0.40	2.40
Roller men	2	0.87½	1.75
Painting curb	1	0.40	0.40
Sweeping base	2	0.40	0.80
Sweeping cement on surface	1	0.40	0.40
Truck dumper	1	0.40	0.40
Finishing edges along the curb	2	0.40	0.80
Miscellaneous	2	0.40	0.80
Watchmen	2	0.40	0.80
Total			$13.30

The total hourly cost for labor, hand method, was $21. At the average rate of 218 sq.yd. laid per hour the labor cost was $0.096 per square yard. By the new method the five rakers were replaced on the payroll by one finishing machine operator at 50c. per hour, effecting a saving of $3.25 per hour and leaving a net cost of $17.75 per hour. The unit cost at the average rate of 334 sq.yd. per hour would be $0.053 per square yard, showing a saving of $0.043 per square yard. While these figures do not take into account anything but labor costs, omitting the saving in superintendence, office overhead, interest charges and other economies due to getting a job completed rapidly, it is obvious that these items would all be in favor of the process described. Where the base is machine finished no additional outlay for equipment is necessary, as the necessary finisher will already be available.

The H. L. Cannady Company, of Tulsa, Okla., was the contractor, with Keen Umbehr superintendent. J. H. Wheatley was chemist, and George Balenti street inspector for the state highway commission. C. L. Donovan, of the Division of Control, U.S. Bureau of Public Roads, who conducted time studies on the project, suggested using the machine, and from his experience in observing the use of machines elsewhere contributed largely to its successful operation.

NINTH OF A SERIES OF ARTICLES

Today in the Mississippi Flood Area

Engineering and Human Conditions in the Basins and Along the Levees as an Engineer Sees Them

IX—The Cypress Creek Diversion Down the Boeuf River

By W. W. DeBerard
Associate Editor, Engineering News-Record

IN THIS the ninth and last of a series of articles on the Mississippi flood situation is concluded a widespread investigation on the ground. Mr. DeBerard drove 5,000 miles through the valley and spent nearly ten weeks in the field, looking at scars of the 1927 flood at Melville, La., quizzing the Weather Bureau forecasters at Cairo and New Orleans, delving into official records of the Mississippi River Commission at St. Louis and Greenville and of its district offices at Memphis, Vicksburg and New Orleans, interviewing cotton planters on the plantations, cotton brokers in the grading rooms, bankers, politicians, realtors and timber owners in their places of business, and engineers everywhere. The five-weeks investigation of last fall represented by the first five articles in the series necessarily had to be restricted largely to functional and economic aspects, since the report of the Mississippi River Commission had not been made public and the engineering staff could not talk about it. The second group in the series takes up the engineering phases and includes a detailed study of the Cairo situation and the Cypress Creek Diversion, both knotty controversial problems, and a review of the methods and engineering involved in the building of levees and revetments, together with certain pertinent observations on river hydraulics. Generally speaking, the engineering phases of such an enormous subject necessarily had to be quite definitely restricted in scope, since any reappraisal, review or repetition of the enormous volume of literature on river hydraulics was impractical in the space available. The engineering therefore was limited to examples of construction and to definite projects and the alternatives recommended in the reports. Reasons, so far as obtainable, were sought for changes in levee design and what that meant in the way of revamping construction methods, equipment and organization.

—EDITOR.

MOST RIVER men are agreed on one point in the complicated Mississippi River problem. That is, that major floods cannot be kept within the levees in the delta region below Cairo and that consequently some provision must be made for the excess water if it is not to be allowed to spread out over the country. As to what provision is to be made, there is pronounced disagreement. Floodways roughly parallel to the main river have been accepted as being the most economical method by both the Chief of Engineers and the Mississippi River Commission. But here, again, there is disagreement as to size of floodway required, type of structure to be used to draw off water from the main river into the floodway, method of controlling the outflow and the amount that can be diverted into the floodway. Slope, cross-section of the floodway and the resistance to flow set up by natural obstacles in the channel are vital factors in arriving at any definite conclusions as to which of the proposed methods is the most desirable. As the proposed Boeuf River floodway is one of

IN THE AREA EAST OF MACON BAYOU RIDGE
Taken in February, but line of high water of 1927 was still plainly visible in the swamp about at the top of the logs and a foot below the top of the car.

the larger and more complicated of the proposed floodways, some observations concerning it may serve to cast light upon the difficulties with which the whole problem is fraught.

With the slope of the Mississippi River north and south of the entrance of the Arkansas River flattened somewhat over that above and below, a decidedly knotty problem in river hydraulics is presented to the engineer. When the Arkansas discharges an unusual amount of water, the problem is accentuated, as this inflow has a tendency to flatten the slope still more above the mouth. Probably at no place in the river are there such enormous oxbow bends. The river runs north more here than at any other place. By carrying a canoe 5 miles across necks one can float *upstream* 40 miles. Levees are high, probably higher than at any other section of the river. Foundations are poor and the material is conducive to seepage. Somewhere in this vicinity the bulk of the finer sands and much of the loess of the Missouri find lodgment.

BOEUF RIVER SECTION REQUIRING MUCH ATTENTION
To get a velocity of 1 ft. per second or more here would not be practical without heavy clearing expense.

The 1927 flood waters from the main stream filled the section nearly if not quite to capacity and the Arkansas tried to add 800,000 sec.-ft. more. Mounds Landing crevasse resulted. It did not remove enough water and the Arkansas levees broke. Finally, Mounds poured out 500,000 sec.-ft. and the three Arkansas breaks 600,000 sec.-ft. These quantities do not mean that 1,100,000 sec.-ft. additional would have had to be cared for, had the levees been high enough to care for the total runoff, because the reduced levels through the crevasse lowered the heights of the river and reduced its solpe and therefore its carrying capacity. Nevertheless the backwater in the delta above the Arkansas held up the head in the river very materially.

Previous high water (1922) registered 58 ft. on the Arkansas City gage. The 1927 crest was 60.5 and had the levees been built high enough to hold the flood the gage would have read 69 ft. The probable maximum flood of 2,850,000 sec.-ft. is estimated by Mississippi River Commission engineers to reach 74.5 ft. Thus for a freeboard of 5 ft. recommended by the M.R.C. the levees must be raised from 60.5 ft. to 79.5 ft., or 19 ft., making them on the average a total of 41 ft., a height considered out of all reason by both M.R.C. and the Chief of Engineers.

Since the runoff must be impounded or pass to the Gulf immediately by some channel and "sideboards" on the Mississippi in its present condition are inadequate, additional channel capacity outside the levees is the only alternative. Until 1920 water could back up Cypress Creek and overflow into the upper end of the Tensas Basin, coursing down both sides of Macon Ridge through both Boeuf River on the west and Bayou Macon on the east side of the ridge. In 1920 the main river levees were extended north across Cypress Creek to join the levees on the south bank of the Arkansas. The flow in Cypress Creek had therefore to be carried by drainage ditches south outside the main channel, but its flow was not augmented by Mississippi backwater.

Since water from the Mississippi in the larger floods, with the exception of 1922, has always coursed down the Boeuf River and Bayou Macon, what more natural thing for the M.R.C. and the Chief of Engineers than to propose that as a definite floodway?

Early in the discussions several (at least six) spillways, each of 100,000-sec.-ft. capacity, needle-controlled, were investigated, but they were found to inundate nearly as much land as the 1927 flood; therefore they were abandoned. The volume could easily be obtained by spillways of 4-ft. depth 1 mile long. In view of the large

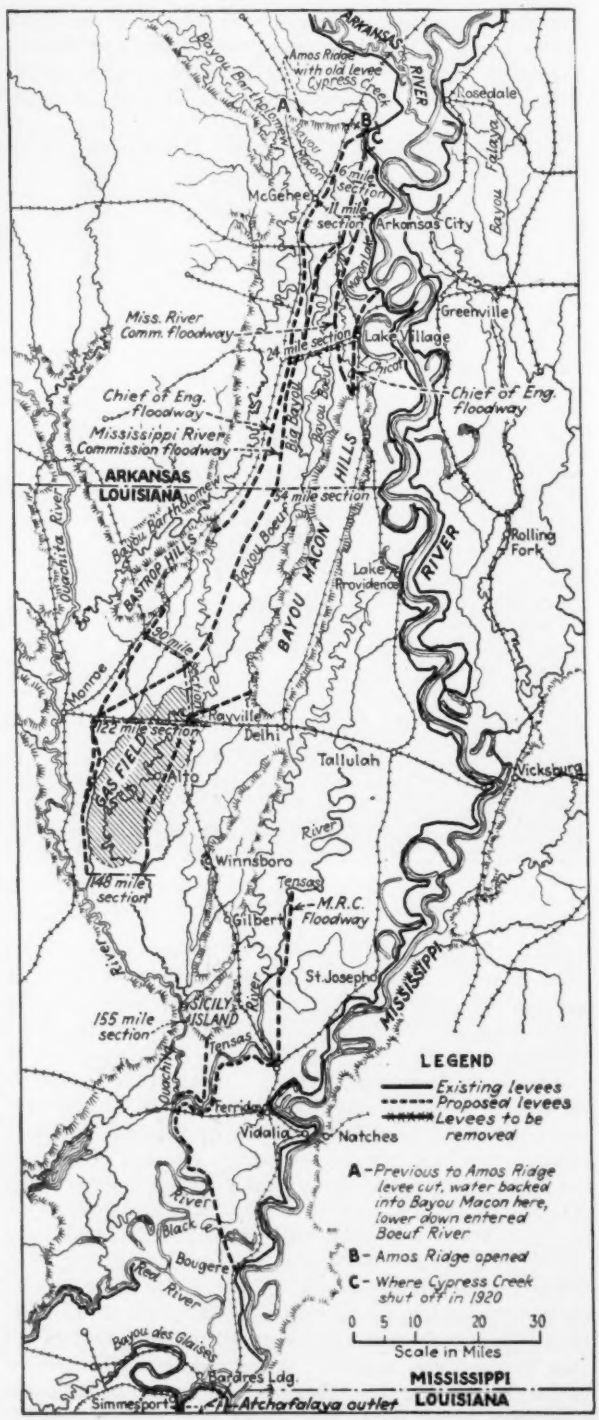
TYPICAL OPEN SWAMP TIMBER IN BOEUF RIVER REGION
Clearing here would be a minimum and probably would not include more than trimming lower limbs and dragging out fallen timber.

area submerged, it was considered better engineering to confine the overflow to one point, and therefore the plan recommended by the M.R.C. was arrived at, not, however, without first making a reservation that storage reservoirs on the St. Francis, White and Arkansas should be further investigated. The studies made were predicated on 90-day storage periods, whereas studies with shorter durations might prove of sufficient value to make them worth while considering.

Boeuf River Diversion—The Diversion Board made a base study on 750,000 sec.-ft., diverted by means of a controlled spillway near the mouth of Cypress Creek, 25 miles below the mouth of the Arkansas and 12 miles above Arkansas City. The route of the water diverted would follow essentially the course of the former flow prior to the closing of Cypress Creek. There was this exception, however, that the water was to be confined between levees in the cleared floodway 3 miles wide for 32 miles and the levee on the east side continued south to the upper end of the Macon Ridge, thus cutting off flow to Bayou Macon and forcing it all down the Boeuf River. The reason for this choice given by the Diversion Board was that the Bayou Macon had the higher land values and a more widely developed terrain. The M.R.C. report reiterates this statement and the Chief of Engineers states that the Boeuf is the most direct route, has the best width and covers largely undeveloped swamp land.

It is to be understood that these three reports all are developed from the same original sources and none was based on extended investigation of the Boeuf River area, because of lack of time. There has been a certain amount of investigation as to population in the area and of the gas well field, thousands of acres in extent, in the vicinity of Alto, southeast of Monroe. The population is in excess of 40,000 people. Farm values recently have been greatly marked up in a wide area by reason of the success of the gas wells, which geologists confidently predict portend an ultimate oil well development of great value to the region.

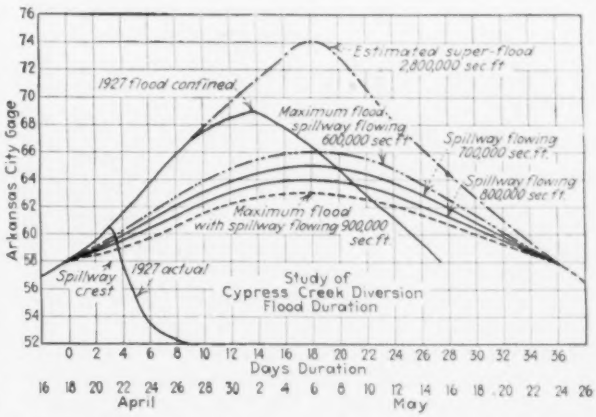
Floodway Capacities—As stated, the base studies were made for a floodway capacity of 750,000 sec.-ft., from which 600,000, 800,000 and 900,000 sec.-ft. factors were deduced. Backwater curves were figured having available only ten cross-sections in 155 miles, two of them assumed. One stretch between sections is 36 miles long and another is 51 miles long, but there was available a



EXISTING AND PROPOSED LEVEES, AND LOCATION OF CROSS-SECTIONS

longitudinal profile. On these sections and profiles are shown the 750,000-sec.-ft. grade with elevations for levees. It is not to be forgotten that the Boeuf runs in a ridge—that is, between levees of its own making. The investigators started with an elevation of water surface of 154 ft. mean Gulf level, equivalent to 50 ft. on the Arkansas City gage, and carried it down to 70 ft. mean Gulf level at mile 155, where it merged into the backwater area above the mouth of Red River below Sicily Island.

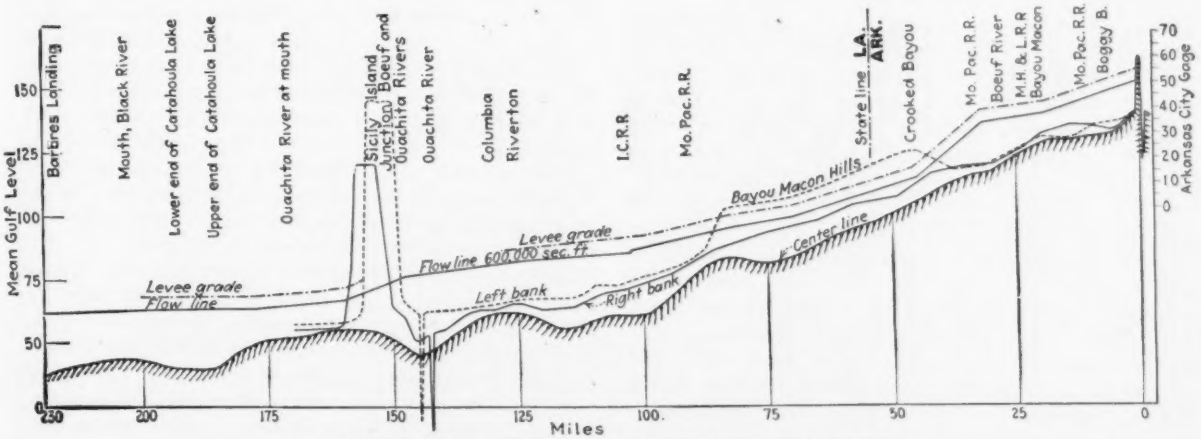
In the Diversion Board report, however, only 600,000 sec.-ft., the approximate amount that went down both the Boeuf and Bayou Macon combined, is recommended, and the M.R.C. sticks to that figure, whereas the Chief of Engineers takes 900,000 sec.-ft. down the same route, widening out the floodway. In the 750,000-sec.-ft. calculations velocities get up to 3.30 ft. per second for cleared and 1.03 ft. per second for uncleared sections, with n in Kutter's formula taken at 0.045 and 0.150 respectively. In the 600,000-sec.-ft. calculation noted in the Diversion Board's report, n was assumed the same, but velocities were somewhat less, the maximum being 2.3 ft. per second for the cleared and 0.83 ft. per second for the uncleared sections. The mean depth for 750,000 sec.-ft. ranges from 10 to 19 ft. and for 600,000 sec.-ft. from 12.5 to 20.5 ft., since the former was in a cleared floodway and the latter uncleared.



LENGTH OF TIME VARIOUS SPILLWAYS WOULD OPERATE

gressional hearings would have paid the bill and some tangible facts would be available upon which engineers could really work.

Property Damage—The Chief of Engineers calculates nothing for property damage which the M.R.C. sets at nearly $100,000,000. Someone must pay these damages and to expect the 40,000 people in the territory to bear any share of the cost is futile were it equitable. The only way is for the state as a whole to assume the expense and that should be the burden of the explanation of its cost-apportionment stand by the administration. With the prospective oil fields owned by nationally known wealthy oil companies and with wide-awake civic organizations in the city of Monroe all on the watch to protect their



LONGITUDINAL PROFILE OF BOEUF RIVER FLOODWAY

An inspection in February of the territory to the east and southeast of Monroe, crossing the sections several times, still disclosed last spring's highwater marks in the forest as plainly as though the water had just receded. A reasonably large staff of surveyors should be able to make cross-sections extremely fast without resort to instrument work for anything but water slope, utilizing the highwater mark as height of instrument. No money for such investigations has been made available, though a tithe of the expenditures that have been made for Con-

DISCHARGE COMPUTATIONS FOR TEN SECTIONS OF CYPRESS CREEK DIVERSION OF 600,000 SEC.-FT.
From Report of Diversion Board, M. R. C.

Section Miles	Width, Miles	Velocity F.P.S.	Slope	Coefficient of Roughness	Hydraulic Radius, Ft.	Discharge Sec.-Ft.	Remarks
0–20	3	2.3	0.000123	0.045	13	620,000	All cleared
20–32	3	1.77	0.000055	0.045	14.25	650,000	All cleared
32–45	6.5	1.30	0.000325	0.15	12.5	590,000	Not cleared
45–72	6	0.83	0.000110	0.15	13.25	625,000	Not cleared
72–85	5.5	0.70	0.000065	0.15	15	610,000	Not cleared
85–102	5.5	0.80	0.000083	0.15	15.5	620,000	Not cleared
102–124	7.5	0.72	0.000039	0.15	20.5	605,000	Not cleared
124–148	10	0.74	0.000048	0.15	18.3	630,000	Not cleared
148–155*	2	2.90	0.000150	0.15	15.75	635,000	Over bank
		7.3	0.000150	0.03	40.5	100,000	Ouachita River

*155—Old River—Floodway merges into backwater area.

ESTIMATED COST OF CYPRESS CREEK SPILLWAY

Concrete:	
Reinforced, 176,000 cu.yd.@$25.00	$4,400,000
Plain, 118,000 cu.yd.@$12.50	1,475,000
Piling:	
Steel sheet 9,200 tons @ $57.00	524,400
Concrete 530,000 lin.ft. @ $1.50	795,005
Revetment:	
4,000 lin.ft. @ $60.00	240,000
Excavation:	
870,000 cu.yd. @ 40c.	348,000
	$7,782,400
Contingencies, about 15 per cent	1,217,600
	$9,000,000

rights, no property is going to be taken unless by "due process of law."

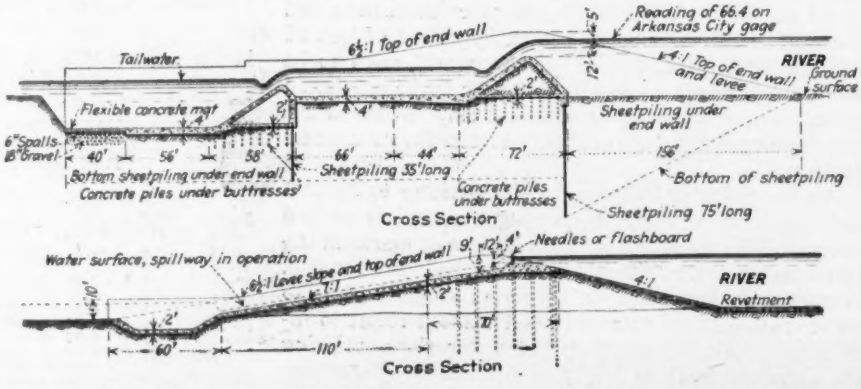
If the Boeuf route is the right one, the Mississippi River Commission estimate is none too large. Engineers of the vicinity who ought to know feel that calculations based on sufficient facts, which are not now available, will call for the use of both routes. If that decision is arrived at, a new appraisal and comparison with higher levees, double lines of levees, new studies of river channel betterment to carry more water in the same channel must be made. The latter proposal does not mean river straightening necessarily, but it does mean a full review of what can be done by revetment and river training for over-bank flows up to the new heights, a study which seems not to have been made.

Spillway—Tentative designs for a concrete spillway as proposed by the Diversion Board and for a similar one for 600,000 sec.-ft. recommended by the M.R.C. indicate provision for a double drop before the current finally reaches tailwater level. This particular design provides for a crest elevation 17 ft. below the levees, of which 5 ft. is the new M.R.C. freeboard recommendation. A 4,000-ft. length, 12 ft. deep, was considered sufficient to withdraw 750,000 sec.-ft. Sheet piles 75 ft. long and concrete piles under buttresses of a hollow or earth-filled dam were suggested. A flexible concrete mat was placed at the discharge end of the tailwater pool. This is very definite in detail even for a preliminary estimate as compared with the "fuse plug" levee section left low for 25 miles in the same general location in the recommendation of the Chief of Engineers. With a spillway, the exact amount of water that can be abstracted from the river for a given gage height is definitely fixed. This is not true with a "fuse plug" levee section. In view of the fact that one of the greatest of crevasses, that at Mounds Landing, discharged less than 500,000 sec.-ft. (468,000 sec.-ft.) and that the three Arkansas River crevasses poured out but 600,000 sec.-ft., there is serious objection to an uncontrolled spillway. Moreover, the matter of subsequent rise of river level complicates matters. Above bank-full stage a crevasse tears out the levee at least to natural ground level and for subsequent floods the river again pours through the opening. Three subsequent rises much lower than the first flooded the Tensas Basin and ruined crops planted in between rises. With a controlled spillway, only the highest floods would be experienced and the planter after an inundation would be protected from small subsequent rises that reach above the bank-full stage but below the spillway crest.

From all investigations made and interviews had during a trip of several thousand miles in the valley no laymen or engineers were found that did not feel that uncontrolled spillways were absolutely indefensible. If the construction of floodways with such spillways at their head depends on local contributions of any kind, they will never be built.

Levee District Interrelations—The two Louisiana levee districts just south of the Arkansas line in the Tensas Basin are dependent for protection on levees on the Mississippi and along the south bank of the Arkansas. In consequence the Louisiana Legislature has granted permission for funds raised in Louisiana to be spent by the levee district in southeastern Arkansas (772,500 acres, 30 to 35 per cent under cultivation), having a levee front on the Arkansas and Mississippi of 149 miles. These Arkansas levees protect 1,000,000 acres in Arkansas and 2,500,000 acres in northeast Louisiana. The two Louisiana districts have paid 50 per cent of the cost of constructing and maintaining these Arkansas levees. The Arkansas District is in very bad financial condition due to bank failures attributed to floods and would have defaulted this year on bond obligations had not the two Louisiana districts come to its assistance. One of these Louisiana districts is solvent, but the financial condition of the other is considered desperate in that it has probably exceeded its legal tax limit and can issue no more bonds. While on the subject of financial condition of the levee districts, which are the state agencies through which local contributions, if any, will be made, eight only out of 28 are reported by the Mississippi Flood Control Association as solvent. The condition of the remainder ranges from bankruptcy to a hopeless financial condition with revenues anticipated several years in advance.

Brief Summary—What then to do about the Cypress Creek Diversion? The Chief of Engineers with his fuse-plug section and no payment for damages or rights-of-way has undoubtedly the cheapest scheme, but it seems impractical of operation in that 900,000 sec.-ft. never yet went through a crevasse, and payment of local damages by the people more or less damaged seems impractical. The Mississippi River Commission's recommendation of 600,000 sec.-ft. partly cleared floodway is excessively expensive and the suggestion of full investigation of reservoir facilities on the St. Francis, Arkansas and White rivers should be augmented by further investigation of channel improvement with a view to carrying more water. The river bed is the cheapest right-of-way!



ABOVE—PROPOSED CYPRESS CREEK SPILLWAY 4,000 FT. LONG TO CARRY 600,000 SEC.-FT. BELOW—PROPOSED SAFETY VALVE SPILLWAYS TO CARRY 100,000 SEC.-FT.

St. Francis Dam Failure—An Engineer's Study of the Site

Signs of Seepage on the West Slope—Deep Scour at West End Indicates That First Failure Occurred There

By Ralph Bennett
Consulting Engineer, Los Angeles, Calif.

THE FIRST REPORT of the failure of St. Francis dam written from an engineering viewpoint was published in last week's issue of *Engineering News-Record*. It was prepared by N. A. Bowers, of the editorial staff of this journal. On the same day that Mr. Bowers visited the dam site, Mr. Bennett, another engineer, made an examination of the site. His conclusions bear out those of Mr. Bowers as to cause of failure and the way in which it occurred. As his observations cover some points not covered by Mr. Bowers' report, they are given herewith. Three illustrations have been added to assist in understanding Mr. Bennett's comment. —EDITOR.

I PUT in all of Wednesday, March 14, 1928, examining the remains of the St. Francis dam of the Bureau of Water Works and Supply of the city of Los Angeles. This structure had failed early the previous morning, as described in *Engineering News-Record,* March 15, p. 456, and March 22, p. 466.

I entered the San Francisquito canyon from the upper end and came down to the site of the dam along the remains of a road on a bench on the east side of the canyon which had been partly destroyed by high slides extending into the shale (metamorphic schist) bedrock. These slides were mostly rather recent, and appear to have been caused by the cumulative penetration of moistur into the toe of the bank as the reservoir level rose. There is a very new slip of similar type just below the east abutment of the dam which appears to have resulted from erosion subsequent to the break.

At the dam site San Francisquito Creek is flowing southwest. The site is on shales having a strike parallel to the canyon and a dip of about 45 deg. to the west. The east bank of the canyon is quite abrupt and rises for several hundred feet on about the dip slope. The west side is more gentle and is cut by erosion into long spurs lying crosswise of the main valley. The dam abutted against such a spur several hundred feet long and very thin.

About 40 ft. of the central gate section of the dam is standing in place or nearly so. Fragments of east end are lying on eroded shale with their stepped faces uppermost and turned about 45 deg. Fragments of west side near the center are lying steps uppermost just back of the standing portion. A 3,000-yd. piece of the west side from about half way up is lying half a mile down stream with part of the cutoff wall and red rock clinging to its base. The concrete is in remarkably large blocks without fractures or cracks of importance. The standing section has a break in the west corner of the upstream toe. The steps of the downstream slopes have broken off smoothly for about 15 ft. at a distance of 10 to 15 ft. above the base. This break is partly undercut and the bedrock there adheres to it.

The main dam abuts at an angle with the axis of a narrow shale ridge running westerly from the arch gravity section of the dam for several hundred feet. A rectangular wall caps this narrow shale spur. This cap wall has numerous old shrinkage cracks, some of which are an inch or more wide and have been calked with dry rope. At a vertical distance of about 50 ft. below this wall the downstream face of the spur has a nearly continuous zone of seepage moisture, including at least one old seep which has recently washed out a piece of an abandoned road.

Water marks on the concrete indicate old vertical shrinkage lines passing through the dam at each end of the standing section. Marks on the face of the structure indicate that it had been filled nearly to spillway level, but that the average level since construction had been quite low.

The west side bedrock is a soft Modelo shale with numerous seams. When wet, this rock muds and appears very soft. When dry, it is rather firm. A considerable portion of the west side of the red shale has been gouged out until a small pond lies on it just above the upper face of the dam. There was also extensive rock erosion just below this wing of the arched dam.

The Modelo shale under the westerly spur has decayed into clay for a considerable depth, and at the junction of the arch and the wing walls part of the concrete of

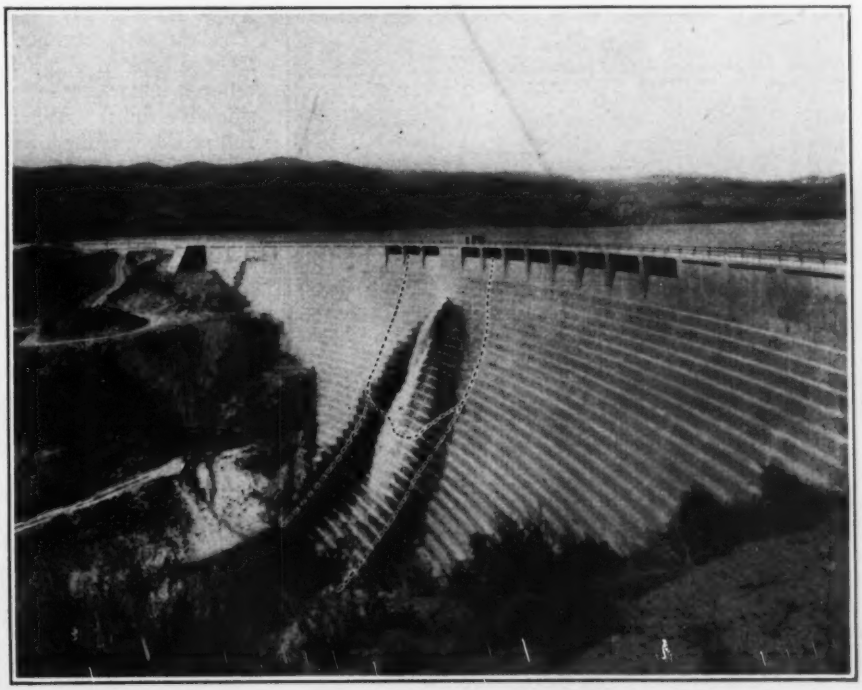


FIG. 1—ST. FRANCIS DAM BEFORE THE FAILURE
Outline of the portion of the dam which is still standing has been indicated on the face of the dam.

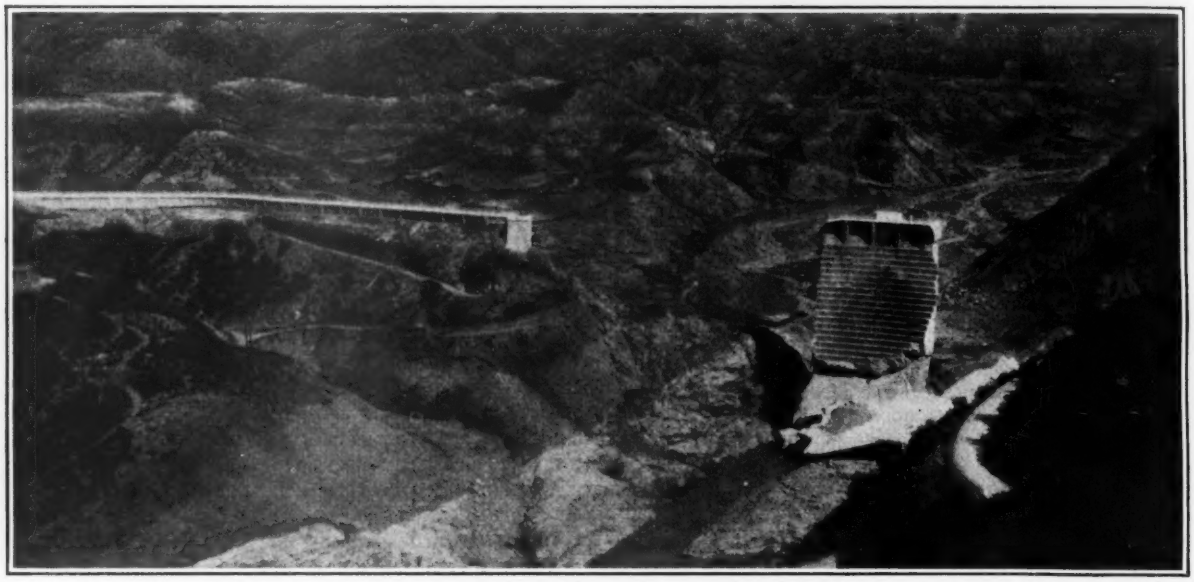


FIG. 2—ST. FRANCIS DAM AFTER THE FAILURE
Note the change in profile of the west slope at the dam from that shown in Fig. 1. Note also the distinct demarkation of the plane between the conglomerate rock and schist as exposed along the west side of the valley.

the arch rested on this decayed rock. Elsewhere there has been so much scour that the original bottom of the dam trench is entirely gone.

The monolithic concrete of the dam is moderately hard and quite uniform. Numerous very large blocks lie about half a mile below the dam. The concrete is entirely without reinforcement except for a thin walkway along the top.

Since the blocks close to the dam are all lying on their upstream faces, it seems that the first motion must have been a downstream motion of the bases of the five or six

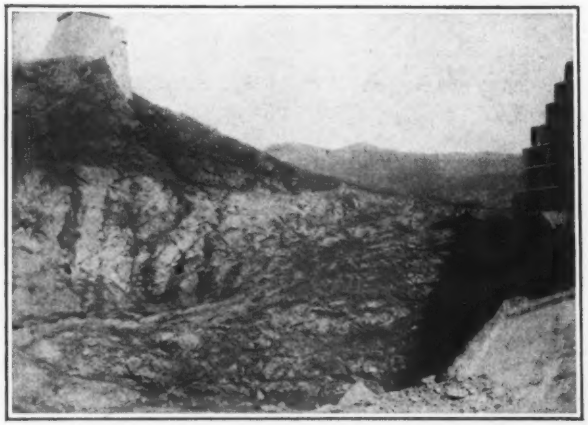


FIG. 3—ERODED WEST SLOPE AT THE DAM

great sections into which the arch dam was divided by vertical shrinkage lines. Possibly the top was delayed by arch action until it had pivoted free of the rock at the upper ends of its abutments. But a rather hurried study of the east end and the position of the blocks and their relative travel indicates a break on the west end first, and the failure of the east end may have been after much of the water had drained from the reservoir.

If the foregoing conclusions are correct, the initial failure must have been due to a leak under the west side about half way up, and at that elevation there is the zone of deepest erosion indicated by a flat or pond still holding water, as well as a pit just downstream therefrom.

There is no evidence of grout holes left in the bedrock if any ever existed. The concrete of the dam shows no observation wells. There does not seem to have been either a concrete or a clay blanket along the reservoir bottom in the vicinity of the dam.

The shales on which this dam stood will stand very high loadings when kept dry and in restraint. But when wet they become both soft and soapy. They are completely shattered and can be picked out in small pieces. They ravel freely where subjected to stream action. That the seams are not entirely tight is evidenced by the leakage back of and below the standing wall. With unrelieved under-seepage the dam must have had very considerable uplift. When this seepage began to produce full pressure at the lower toe the rocks must have raveled very readily and the originally minute passageways must have enlarged very rapidly into destructive channels which ate out under the arch at an accelerating rate until the structure fell into the hole so excavated.

The section left standing is in the bottom of the original gorge, and is probably standing on rock that had been continuously moist. The sections that failed were on the dry flanks of the gorge.

The failure appears to have occurred almost as soon as the water level was raised above the contact zone and appears to have been in the claylike conglomerate.

Belgrade Seeks Highway Construction Loan

A highway construction loan is desired for Belgrade, Yugoslavia, to meet the needs of the Belgrade district, which covers much of the rich agricultural lands lying between the capital and the Hungarian frontier. The proceeds of the loan are to be used for the construction of highways and building a bridge across the Tisza River. The amount desired is about $9,000,000, of which about $5,500,000 will be employed for road building and about $3,500,000 for the bridge.

Clemens Herschel at 86

An Editorial Appreciation

IT IS given to few engineers to attain such eminence in their profession as has been won by Clemens Herschel. Fewer yet reach the age of 86, as did Mr. Herschel on March 23, or meet with a circle of friends and respond to their congratulations, as he did in his well-known forceful and genial way.

There is no accepted unit of measurement for such a man as Clemens Herschel. Great as have been his contributions to engineering knowledge and practice, including engineering economics, he has contributed quite as much to the advancement of his profession and to mankind through his never-failing help of hand and heart to his immediate associates and to all others who have sought from him information or advice.

Mr. Herschel's contributions to the science and art of engineering stand out most conspicuously in the field of water utilization both for power and for municipal supply. Geographically, his work in these respects centers at Holyoke and Niagara Falls as regards water power, and in northeastern New Jersey in respect to municipal water supply, though he also did much consulting work for other localities. Technically, Mr. Herschel has contributed heavily to the highest possible development of power from falling water and to the art of measuring water so that its use or waste might be known more accurately. More specifically, at Holyoke a half century ago, as engineer for the Holyoke Water Power Company, Mr. Herschel did valiant pioneer work in establishing a basis of charges for water used for power by the various mills, in determining the laws of water flow, in testing waterwheels and, to crown the rest, in the invention of the Venturi meter, long since used the world over for measuring the flow of water and other fluids through large conduits.

Mr. Herschel's invention of the Venturi meter illustrates his grasp of scientific fundamentals and application of them by the simplest possible means to attain great ends, with resultant world-wide benefit. The Venturi meter, though it may be applied to small rates of flow, has its great field in measuring and recording very large volumes of flow in pipes or channels. Putting to practical use Venturi's early demonstrations that water could be passed through a contracted channel without diminution in volume of flow and with but slight loss in pressure, Mr. Herschel established the best proportions for contraction and re-expansion, and then had the original conception of utilizing the slight loss of head to indicate the rate of flow. The creation of this simple and wonderfully effective measuring device is an engineering triumph that alone is sufficient monument for any man. Yet because of his own scientific modesty it is known—and probably always will be known—not as the Herschel but as the Venturi meter.

It was significant service, also, that Mr. Herschel rendered in advancing the development of the use of plate steel for large water-supply conduits. He gave special impetus to its use, when, as chief engineer for the East Jersey Water Company, he built the Pequannock supply works for the city of Newark, in the early nineties. On this enterprise, a large one for its day, Mr. Herschel's energy and resourcefulness showed the man as a great construction engineer.

Although Clemens Herschel will go down in engineering annals as a hydraulic engineer, it should not be forgotten that for fifteen years after his technical schooling at Harvard and at Karlsruhe he worked chiefly as a bridge engineer. His attainments in this field led to two years of service on the Massachusetts Railroad Commission in the early eighties, shortly after he took up hydraulic work at Holyoke. Even before this his bridge work had led him to write a book, "Continuous Revolving Draw Bridges," published in 1875. Further proof of the breadth of his abilities may be seen in the fact that in those relatively early years he won a state prize for an essay on highway construction.

As a writer he made his most notable achievement in translating into English in 1899 a Latin manuscript by Frontinus entitled "The Two Books on the Water Supply of the City of Rome." Just previously he had brought out another important work, "One Hundred and Fifteen Hydraulic Experiments," an exhaustive study of pipe capacity, developed as a byproduct of his work with water conduits made of riveted wrought-iron and steel plates.

At 75, an age when most engineers still living take little part in professional work, Mr. Herschel, then vice-president of the American Society of Civil Engineers, stepped into the breach caused by the death of the president, Elmer L. Corthell, and did able service as his successor. The dozen years that have passed since then have left Clemens Herschel so hale and hearty as to give his many friends hope that he will be spared for many years to continue the advice, encouragement and inspiration that have been his characteristics for well nigh threescore years and ten.

Facilitating Traffic and Safety

I do not feel entirely out of sympathy with the village board of Podunk if in their resentment at the road hogs from the city they grasp at the only remedy they know—namely, a stop-and-go signal light, and then run it at unreasonable as well as at reasonable hours. It is quite obviously our job as engineers to find the happy medium between the extremes. We must by all means remove unnecessary irritants to traffic, both the elemental irritants of mud and of darkness and the man-made irritants of unwise restrictions. I do not know anything more irritating than to have a big car or truck dashing up to a stop sign or a red light and stop squarely across the crosswalk which I as a pedestrian am desirous of using. Only a minority of drivers do this, but unfortunately the minority is not labeled and the poor pedestrian never knows just which driver is going to respect his privileges and which is going to make him jump for his life. That is one of the chief reasons why so many still prefer to jaywalk in the middle of the block, where they can at least see what is coming. It is up to us as engineers to solve these present problems on the basis of equal consideration to all. Safety is the first consideration; many a traffic light is really needed for the protection of pedestrians, even though not at all for the expediting of traffic. If used only at the hours when it is needed, such a signal or the equivalent officer is not an unreasonable irritant. Then, if safety has been provided for, we as engineers will prescribe only such signals, devices and equipment as will expedite and not delay the traffic, both vehicular and pedestrian. —*Sidney J. Williams, before American Road Builders Association.*

Rules for Foundations on Yielding Soils Found Unsatisfactory

Tests Made at Nebraska State Capitol Do Not Bear Out Proposed Rules for Bearing Capacity of Such Soils

By Ralph H. Chambers
Consulting Engineer, New York City

CERTAIN definite rules to govern the design of foundations on clay, sand and mixed materials have recently been propounded by Prof. Charles Terzaghi and were published in the November, 1927, *Proceedings* of the American Society of Civil Engineers. These rules, could they be accepted without reservation, would bring to a field where general rules have heretofore been few a measure of much-desired certainty and assurance. But unfortunately there are facts and observations in the experience of many engineers that will be hard to reconcile with the rules proposed.

The first of these rules states a definite relation between the size and bearing capacity of a foundation as follows:

> For soils with great cohesion the settlement produced by a given unit load increases in direct proportion with the diameter of the loaded area.
>
> On the other hand, for perfectly cohesionless soils, the size of the area has very little effect.

The first of these theorems is derived from experiments, made in 1916, by a committee of the Austrian Society of Engineers and Architects and from the experiments of A. T. Goldbeck of the U. S. Bureau of Public Roads. The definition is based upon the property of cohesion, but that this property does not determine such a relation is shown by the tests made in December, 1921, at Lincoln, Neb. These tests were made as a preliminary to the design of the Nebraska State Capitol.

Tests Made for Nebraska Capitol

The site of the Capitol, like a large section of the prairie country, is underlain with a dry loess, in thickness 14.5 to 29 ft. This lies upon an irregular stratum of gravel varying in thickness from 1.5 to 25 ft. Below the gravel lies a very deep mass of clean, bright sand, very weakly cemented together. This is the so-called Dakota sandstone. It can be easily cut by a metal tool or scraped out with a hoe, but when taken out in lumps or blocks it retains its form, although it can be easily broken by light blows or by pressure. It is not plastic, but it has a cohesion much greater than clay, although much less than most rocks. Before the foundations for the Capitol were designed it was determined to test the bearing capacity of the loess and of the Dakota sandstone. In order to form some conclusion as to influence of the size of foundations upon the bearing capacity, two tests upon the sandstone were planned, the second to be made upon an area four times that of the first.

These tests were made, under the direction of the writer and of his associate, Edwin S. Jarrett, by Prof. Clark E. Mickey, of the University of Nebraska, assisted by the Nebraska Department of Public Works. The tests were made with every possible refinement, even to the reading of the settlements by microscope upon polished and etched steel bars. The bearings were made through a heavy special casting, and the load consisted of steel T-rails carefully disposed. The surface of the sandstone tested was 27 ft. below the surface of the ground.

The results (*Engineering News-Record*, Oct. 12, 1922) were: An area 1 ft. square failed at a load of 63.2 tons, and the bearing casting sank 6⅛ in. into the broken sandstone. An area 2 ft. square failed at a load of 94.4 tons per square foot, and the bearing casting plunged 13 in. into the disrupted sandstone. The settlement in the two tests, up to the amount of load that caused the failure of the smaller area, was approximately equal.

Thus these carefully conducted tests, on cohesive material, showed that the larger area (twice as great in diameter) carried a load 50 per cent greater than the smaller, with a settlement proportionately equal, a result quite opposite to what might have been expected in accordance with the proposed rule.

Nearly all loading tests have been made upon areas of 1 sq.ft. Foundations of actual structures are 10, 20 or, in the case of mat foundations, 100 ft. square or more. Settlements of test areas of ½ in. or more are common, but what engineer could anticipate with equanimity a probable settlement of the finished structure of ten, twenty or 100 times ½ in.? Except in unusual cases a settlement of 2 in. more or less is not common, and therefore the truth of the author's rule when applied to full-sized structures cannot but be questioned.

Ohio Bell Telephone Building Tests

In *Engineering News-Record* of March 3, 1927, appeared a description of the foundations for the Ohio Bell Telephone Building in Cleveland, Ohio, by R. P. Wallis, from which the following is quoted:

> The clay deposit at 53 ft. depth below surface afforded an ideal medium of support for heavy loads if distributed by a properly designed mat. . . . The use of this concrete mat covering the entire area was dictated by the character of the clay, the material having relatively low supporting value when loaded on small areas but adequate supporting value on large areas.

Whether Mr. Wallis based this statement upon actual tests or was simply stating his opinion does not appear, but there is no doubt that such a belief has been held by many engineers.

If the proposed rule is accepted literally, then it must be believed that in a foundation consisting of a number of footings of different sizes and in close proximity the unit-bearing capacity of the clay under each of the footings will be different, a conclusion that will be hard to accept.

The practice, for many years standard in Chicago, of proportioning footings upon the homogeneous clay existent in that region on the basis of a uniform unit load regardless of the size of the individual footings produced settlements that were at least practically uniform.

Bearing Power of Cohesionless Soils

As to the second theorem of the rule that "for perfectly cohesionless soils the size of the area has very little effect," the author does not give any experimental data upon which he bases his conclusion. He does give, however, in an article in *Engineering News-Record* of Dec. 31, 1925, the results of tests made on very small areas of clean, thoroughly compacted sand, as reported by Dr. Otto Strohschneider of Vienna, as follows:

> The ultimate bearing capacity of clean, thoroughly compacted sand amounts to 0.29, 0.42 or 0.61 kg./cm.²

according to whether the diameter of the loaded area is 0.8, 1.25 or 1.78 sq.cm., and it is known that a circular footing 1 m. in diameter resting on such a sand could carry a load several times as great without objectionable settlement, so that it is clear that the bearing capacity of sand increases rapidly with the size of the loaded area.

This statement, as well as the one that follows it in the same article, "In the case of plastic clay, on the other hand, the bearing capacity is almost independent of the area of the loaded surface. . . . Soils intermediate between sand and clay will have intermediate properties," is entirely at variance with his later conclusions. As to the behavior of the plastic clay, he is evidently converted by the tests he has cited, but why he reverses his opinion as to the behavior of sand is not stated.

Tests on Distribution of Pressures

The author calls attention to the results of tests made by Prof. M. L. Enger, of the University of Illinois, on the distribution of pressures under spread foundations. These are of particular interest in relation to the use of mat foundations, instead of isolated footings, a plan which of late has come into some use after a period of disfavor. It should be borne in mind, however, that Professor Enger's experiments were made on "granular materials" and, as the author has indicated, it is unsafe to reason as to the action of clay from data obtained by experiments on sand. If, however, both plastic and cohesionless materials react similarly under a spread load, there would seem to be a large measure of economy, as well as of certainty, in the use of isolated footings and when, with this, is considered the difficulty and in many cases the practical impossibility of making the mat concentric with the actual live and dead loads, the former suspicion and disfavor under which the single mat or raft type of foundation labored would seem to have been well founded.

The author states that the settlement of a foundation at a depth, compared with the settlement of a like foundation resting upon the surface, will vary as the ratio between the depth and the diameter. This and the further statement that "for perfectly cohesionless materials a ratio of depth to the diameter of the foundation equal to 1 almost triples the bearing capacity and reduces the settlements to one-third of what they would be if the footing rested on the surface of the ground" will be found by many very difficult to accept. According to this rule a small pier 4 or 5 ft. in diameter would not have to be sunk far into a fine water-bearing sand before it would have a sustaining capacity almost equal to rock.

Bearing Capacity of Piles

The author's views as to the fallacy of piledriving formulas, based on impact and penetration, are views probably held by most engineers who have been much concerned with pile foundations, but this is a matter of minor importance compared with the point emphasized and too often overlooked that the bearing capacity of individual piles is not often a measure of capacity of the whole foundation. Particularly is this true of piles driven into comparatively soft and plastic materials of depth much greater than the length of the piles, with the object either of compacting the material or of developing a sustaining capacity that is probably akin to buoyancy. In cases of this kind piledriving formulas and loading tests of small groups of piles are either useless or in most cases entirely misleading, and the engineer must fall back upon his experience under similar conditions. Some degree of settlement under these circumstances must usually be expected.

A recently constructed foundation built under the writer's supervision illustrates these statements in a convincing manner.

Uniform Settlement of Cement Silos

A cement-manufacturing company desired to build a group of eight cement storage bins or silos, 37 ft. inside diameter and 60 ft. high, upon a small projection of land out into Cayuga Lake near Ithaca, N. Y. Borings showed that the material below the ground surface was a comparatively soft homogeneous clay, interspersed with pieces of broken shale rock. This clay was of approximately the same consistency down to rock, which lay at 80 to 95 ft. below the concrete bottom of the bins. Timber piles were chosen as a foundation, to be driven as deep as possible, up to a maximum length of 65 ft. The piles, specified and used, were of unusual size, least diameter at tip 8 in. and at butt 14 in. All piles were driven on 2½-ft. centers by single-acting steam hammers, ram 5,000 lb., drop 3 ft. All piles were driven to a final penetration of 1 in. under the last four blows. It was found that, in general, piles could be driven only 25 to 40 ft.

In accordance with the *Engineering News* formula (for steam hammers) each pile should have had a safe capacity of more than 42 tons, but although the final load on each pile would be only 18 tons it was expected that there would be some settlement—how much could not be predicted.

When the silos were completed and partly filled, they began to settle. They were completely filled, and under this load (18 tons per pile) the settlement continued at a uniform daily rate of $\frac{3}{64}$ in. This continued for two months and then stopped abruptly. Since then a period of six months has elapsed without further settlement, although the bins have been repeatedly emptied and refilled. The total settlement was 7.08 in., and this settlement was almost exactly uniform at every point on the symmetrical concrete mat, so that the utility of the bins was not impaired.

Piledriving Compacts Soils

Another point which this work developed was that, although there was a considerable lifting and swelling of the ground surface around the piles, the very plastic clay was thoroughly compacted by the pile driving. The author states that, in general, plastic materials cannot be so compacted. The compacting of the clay was shown by some additional borings which were made within the area occupied by the piles. These borings were made with great difficulty. It was found exceedingly hard to drive the pipe casing and to pull it upon the completion of the borings, whereas before the piles were driven these operations were accomplished with comparative ease.

The tests and experiences which have been cited, as well as others which the writer believes will occur to many engineers, show such a wide divergence from the proposed rules that it is fairly evident that the time has not yet come when these relations can be stated by formula. There is an urgent need of full-sized tests of all these matters, and until these are made the engineer must necessarily be governed only by the results of his experience.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Resilted Borrowpits Provide Material for Raising Dikes

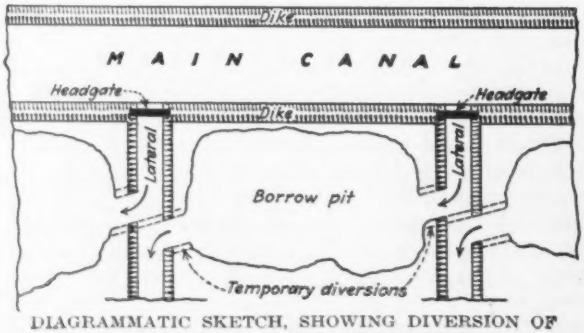
THE NECESSITY for grade changes in some of the irrigation canals of Imperial Valley in California has made it necessary to raise the dikes considerably. In most cases these dikes were originally built with material obtained from borrowpits alongside, and it was not considered safe to take more material from the same source for raising them, particularly in view of the increased height of canal water level that would follow.

The problem of securing material at low cost for raising the dikes has been solved very satisfactorily wherever it has been possible to divert the laterals temporarily so as to cause silt to deposit in the old borrowpits. That is, by turning the flow from one lateral through the intervening borrowpit into the lateral next adjoining, there was thus provided an enlarged channel for a short distance with a corresponding decrease of velocity. Under these conditions silt filled up these pits in a short time. In some cases borrowpits 30 to 40 ft. wide would be filled to depths of 6 or 8 ft. in about six months.

REFILLED BORROWPIT PARTLY EXCAVATED, BESIDE DIKE
Part of the refill has been used in raising the dike.

When the pits were thus silted up the water was turned back into the usual channels and the material from the pits was removed. In some cases the filling process was repeated, and wherever considerable increases in dike heights were made the borrowpits were finally silted up and left in that condition, to avoid any danger to the dikes that might result from having near-by borrowpits filled with seepage.

This work is regarded as maintenance and is done under the direction of M. J. Dowd, chief engineer, Imperial Irrigation District.

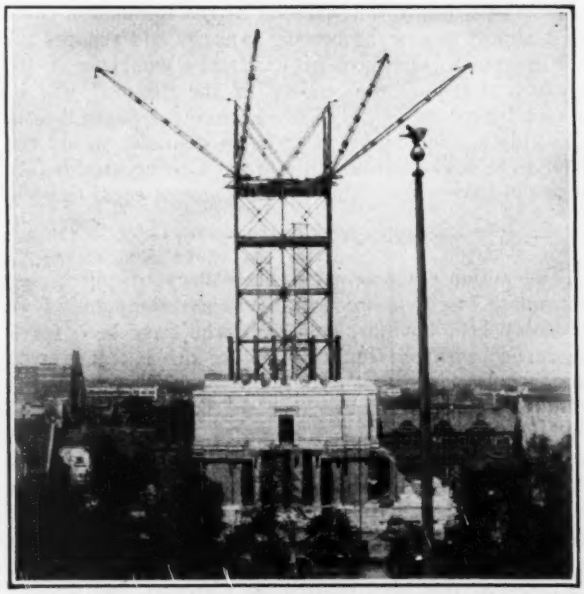


DIAGRAMMATIC SKETCH, SHOWING DIVERSION OF LATERALS TO FILL BORROWPITS

Steel Tower for Masonry Erection

FOR the erection of the World-War Memorial at Indianapolis, Ind., a steel falsework tower 200 ft. high was built in the center of the masonry structure to carry a working platform and derricks for handling the massive stonework, concrete, structural steel and other materials. This square tower consists of eight columns connected by struts and diagonal bracing, and further stiffened by an I-beam framing about 25 ft. from the top, while at the top is an I-beam grillage for the deck or platform. At each corner of the platform is a steel stiffleg derrick with 100-ft. boom; the hoisting and swinging cables are led to electrically operated hoists at the main floor level. A wooden stairway for the workmen was suspended from the framing by cables.

In the accompanying view the erection tower is shown as the work stood in September, 1927. In January, 1928, the masonry shaft, 90 ft. square, had been carried up to about 200 ft. above the street level and the steel

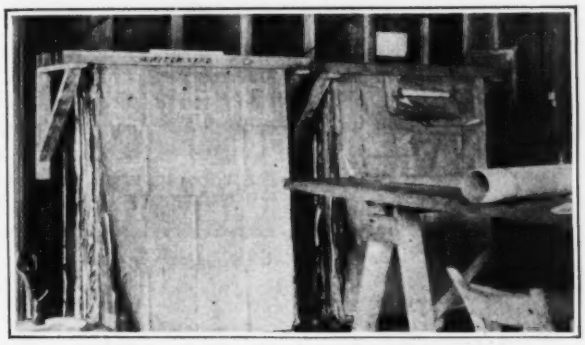


ERECTION TOWER WITH FOUR DERRICKS

framing for a pyramidal roof was being placed. The Hunkin-Conkey Construction Company, Cleveland, Ohio, has the general contract, with T. B. Bond as superintendent. The erection tower was built and erected by the Central States Engineering Company, Indianapolis. Walker & Weeks, Cleveland, Ohio, are architects for the Indiana World-War Memorial Board.

Keeping the Office Blueprint File Intact

THE DIFFICULTY of keeping intact a complete set of blueprints in the field office has been solved on the Bucks Creek project in California by bolting them together. That is, the complete set is assembled in the



OFFICE FILE OF BLUEPRINTS ON THE BUCKS CREEK PROJECT

proper order, two strips of wood are placed along the left margin, one above and one below the group of blueprints, and ¼-in. stove bolts are then used to clamp the two wood strips together, thus firmly holding each blueprint in place.

On this particular job there are 17 major features, such as dams, tunnels, penstocks, etc., and it has been found of material advantage to assemble a complete set of blueprints on each feature, bolt them up as described in the foregoing and keep them hung on a rack on the office wall.

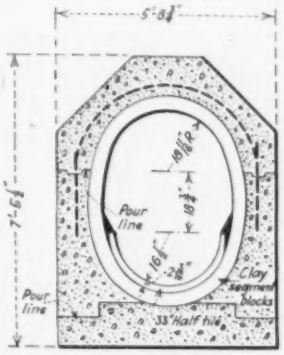
The wood strips which clamp the blueprints together extend 3 or 4 in. beyond the blueprints at top and bottom, this projection being used to support the assembly on two brackets fastened to the wall for this purpose. The name of the major feature is lettered on both the face and the top of the upper wooden strip to facilitate ready identification.

This arrangement was worked out by Ross White, resident engineer on the project for the Feather River Power Company.

Industrial Plant Sewer Uses Double Lining

SEWERS in industrial plants often must function under unusual conditions. The accompanying sketch shows a cross-section of a new sewer being installed at the Middletown (Ohio) plant of the American Rolling Mill Company. The sewer is of heavy concrete construction with an elliptical lining of clay segment block, on top of which is a bell-less half-tile lining in sections 36 in. long. Joints for the lining were made with a mortar of two parts silica sand and one part portland cement.

Although this type of construction was considered ultra conservative it was felt that its use was justified as an added precaution, since for approximately 1,000 ft. of its length the sewer is directly under a railroad track and in addition is subjected to sulphuric acid wastes from the sheet steel picklers. Handling and neutralizing acid sewage has always been a troublesome problem, leakage from acid sewers causing considerable foundation trouble. Since it is not always possible to know where the leak is taking place, such sewers are always a source of danger. In this sewer, in order to minimize the damage due to the highly acid sewerage 3,000 or 4,000 g.p.m. of water will be diverted into its upper end from the hot well at the power house. It is felt that this continuous flow of water will dilute the sewage and because of the hardness of the water will largely neutralize the acid.

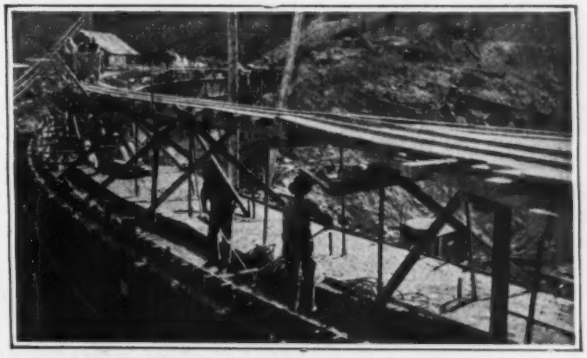


DOUBLE-LINED SEWER FOR INDUSTRIAL WASTES

Trestle for Concrete Delivery Supported on Bents of Scrapped Pipe

IN THE construction of the Grizzly Creek diversion dam on the Bucks Creek project in California, concrete was dumped into place from cars that moved from the mixer along a trestle supported on the concrete already poured. The most convenient means of supporting the runway was to use bents of scrap pipe or scrap iron rail of light weight, as shown in the accompanying picture.

Rails or pipe, as the case might be, were cut with a torch to uniform length, usually about 10 ft., and were placed in the concrete before it had taken its final set. The usual custom was to thrust the metal down into the



SCRAP IRON SUPPORT FOR CONCRETE TRESTLE ON GRIZZLY CREEK DAM

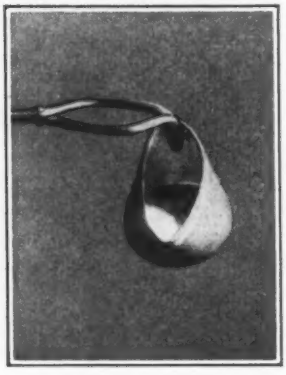
concrete for about 1 ft., taking care to keep the tops of two batter posts that constitued each bent at approximately the same height.

The bents were spaced 8 to 10 ft. apart and ordinarily a 4 x 4-in. cap was used. Scabs and wire were used to fasten the cap to the batter posts and sometimes guy wires were also used to steady the bents. The trestle was then completed with stringers, ties and board flooring in the usual way and was used until concrete had reached a stage high enough to support the next succeeding trestle.

Tin for Pouring Tars Into Molds

By John S. Crandell
Professor of Highway Engineering, University of Illinois

THE most convenient way to pour tars or asphalts into the molds of the various testing apparatus is as follows. Squeeze a small-size ointment tin box until it takes the shape shown in the figure herewith. The squeezing may be easily done with the fingers and thumb. The ointment box may then be used directly over the flame for heating the bitumen which is placed in it from a larger vessel. When ready to pour into the mold, pick up the box with pincers. Pouring may be accomplished without the loss of a drop of material, and with the elimination of the smearing up of the mold that so frequently occurs when pouring directly from a spoon or a can. The box may be labeled for future reference if the material in it is to be soon heated and used again.

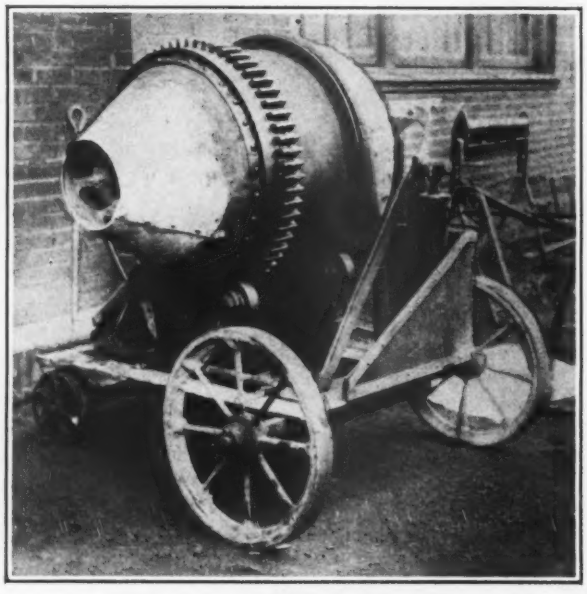


OINTMENT TIN USED FOR POURING TAR AND ASPHALT

A Home-Made Concrete Mixer

FOR concreting a pipe tunnel at the shops of the Louisville & Nashville Railroad at Louisville, Ky., where only limited working space was available, a special mixer was rigged up, as shown in the accompanying illustration. Its batch consists of one-half sack of cement, one sack of sand and two sacks of gravel.

The drum, geared to a small compressed-air motor, is 26 in. in diameter and 24 in. long, with 14-in. spout and 10-in. inlet. Two pneumatic cylinders or air jacks 3x16 in., controlled by a four-way valve, serve to tilt the drum in discharging its batch. Both the fixed and tilting frames are built up of 4x4-in. angles. The machine is mounted on a four-wheel truck as shown. Its total weight is about 1,725 lb. Pneumatic operation was adopted for the reason that the entire plant is served by a system of compressed-air piping, to which the machine could be connected conveniently at various points.



IMPROVISED AIR-OPERATED MIXER

From Job and Office

Hints That Cut Cost and Time

Cost of Water Storage in Steel Regulating Tanks

COSTS OF steel tanks used as regulation or distribution reservoirs by water companies in California were compared at a recent meeting of the California Section, A.W.W.A., in a paper by I. E. Flaa, office engineer, Spring Valley Water Company, San Francisco. Three tanks, all of recent construction, were analyzed in detail to ascertain the effect of various factors on the cost per unit of capacity. Size, ornamentation and type of construction were shown to cause wide variations in the unit cost.

COST OF FOREST HILL TANK AT SAN FRANCISCO

Grading and excavation		$1,394.46
Concrete foundation		3,012.80
Construction and erection:		
Plates, beams, bars and rivets	$2,171.99	
Cleaning and shipping plates	382.03	
Fabricating and erecting tank (contract)	2,680.00	
Asphaltic mastic for joint	263.62	
Miscellaneous	134.91	5,632.55
Roof cornice work, etc. (contract)		2,588.00
Engineering		767.20
Miscellaneous		20.00
Total		$13,415.01

or about $44,269 per million gallons storage.

The Spring Valley Water Company last year built a 300,000-gal. cylindrical tank as a regulating reservoir in the Forest Hill district. This tank is 45 ft. in diameter, is set on a reinforced-concrete base and has side walls 26 ft. high in which $\frac{5}{16}$-in. steel plate was used for the full height. It is located in a high-class residential district where special architectural treatment was required. The roof has asbestos shingles and is surmounted by a ventilator of attractive design in keeping with the ornamental cornice. The rafters are supported on the steel side walls and also by five steel columns within the tank.

In preparing the foundation it was found that, to obtain the desired assurance against settlement, extra excavation was necessary, the material removed being replaced with concrete. The use of the $\frac{5}{16}$-in. plates,

COST OF 300,000-GAL. TANK FOR SAN JOSE WATER COMPANY

Excavation, 400 yd. at $1		$400.00
65 yd. gravel at $2.50	$162.50	
100 bbl. cement at $2.60	260.00	
3,060 lb. steel at $0.04	122.40	
Labor on steel at $0.02	61.20	
Labor mixing and pouring at $2	130.00	
Miscellaneous	100.00	
	$836.10	
Contractors' profit at 10 per cent	83.61	919.71
Steel shell and roof (contract)		3,700.00
Cartage on steel shell, 25 tons at $1		25.00
Painting tank		300.00
		$5,344.71
Miscellaneous		155.29
Total		$5,500.00

or $16,500 per million gallons.

From Job and Office

For Contractor and Engineer

which are heavier than would have been used if new material had been purchased for the job, was decided upon when it was found that the company had for many years been keeping these plates in storage for use in a larger tank. Altogether these items account for the rather high cost, $13,415, or $44,269 per million gallons.

In contrast to this the San Jose Water Company recently erected a 300,000-gal. tank of similar design—namely, steel side walls and reinforced-concrete base—that cost very much less. The thickness of the steel plates in the San Jose tank ranged from $\frac{5}{16}$ in. at the bottom to $\frac{3}{16}$ in. in the top course; no special ornamentation was required, no steel angles were embedded in the concrete base and no columns were used to support the roof, which is a simple cone made up of steel plates. This tank was built at a total cost of $5,500, or $16,500 per million gallons.

COST OF MARIN MUNICIPAL WATER DISTRICT TANK AT TIBURON

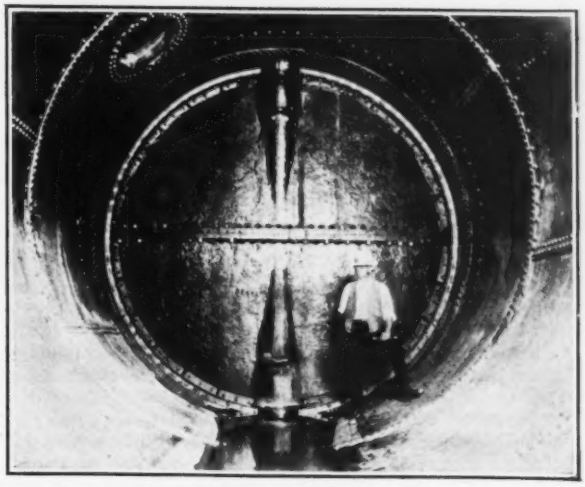
	Complete Cost	Approximate Unit Prices
Contract price for fabrication and erection of steel tank	$18,575.00	1¼c. per gal.
Building 4,028 ft. of road to tank site	2,174.00	54c. per ft.
Excavation for tank foundation	2,777.00	94c. per cu.yd.
Preparing foundation: Grading, rock, screening, oil, sand, equipment, rolling	856.00	11c. per sq.ft.
Painting inside of tank and outside of bottom with bituminous paint	2,530.00	11c. per sq.ft.
Painting outside of tank, inside of roof and structural steel	980.00	3½c. per sq.ft.
	$27,892.00	or $18,595 per m.g.
Valves and piping	1,281.00	
General	131.00	
Total	$29,304.00	or $19,563 per m.g.

An all-steel tank to store 1.5 m.g. built by the Marin Municipal Water District is 95 ft. in diameter and 30 ft. high, located near the town of Tiburon. Unlike the others, this tank has a steel bottom, and plate thicknesses range from $\frac{5}{8}$ in. for the bottom course to $\frac{1}{4}$ in. for the top course, the bottom being of $\frac{3}{8}$-in. steel and the covering of No. 10 gage welded steel, supported by channel columns. The foundation includes no concrete, but was prepared by putting down a layer of clay with a maximum thickness of 5 in. at the crown. The foundation was carefully wet, rolled and surfaced with crushed rock and road oil into which screenings were thoroughly rolled and over which was placed a final finish of sand 2 in. thick. The total cost of this job was $29,304, or $19,563 per million gallons.

Low Leakage from 14-Ft. Butterfly Valve Under Pressure

ON THE Lake Chelan hydro-electric development in Washington recently there was installed a butterfly valve 14 ft. in diameter used for closing off the flow through a riveted steel penstock. The valve is designed to withstand a head of 46 ft. and under full pressure the leakage past the seat rings was found to be only 2 g.p.m. A factor in securing this degree of tightness in a valve of this size and type is said to be the adjustable bronze seat rings that are fitted to the valve disk.

The valve is operated about a vertical axis but does not contain a full-length axle, the casting being heavy enough to make this unnecessary. Both the body and the disk of the valve were made in sections to keep within railroad clearances. The bypass valve is of the needle type and the step or thrust bearing is placed beneath the penstock in a pit where it is accessible at all times.



THE 14-FT. BUTTERFLY VALVE IN SERVICE AND UNDER PRESSURE

The valve was manufactured by the Pelton Water Wheel Company in San Francisco.

Barges Place Bridge Falsework at High Tide

THE STEEL arch centers for the concrete arches of the Arlington Memorial bridge across the Potomac River at Washington, D.C., were recently placed by an ingenious method. Two barges were tied together and braced by timber trusses placed near their ends, with the top chord of the trusses at the deck level. On the barges the falsework for the arch centers was supported on screw jacks, after which the barges were floated into position between the bridge piers. At high tide the centers were adjusted to position and brought to bearing on falsework upon the bridge pier masonry. The barges were removed with the fall of the tide, leaving the arch centers in position for the concreting to proceed. The work is being done by the Hunkin Conkey Construction Company, Cleveland, Ohio.

Job and Office Notes

THE 7x9-FT. TORO TUNNEL being driven for the Montecito County Water District near Santa Barbara, Calif., which is being driven with one machine and mucked entirely by hand, was recently advanced 521.1 ft. in 30 days. This is claimed to be a record advance for one machine and hand mucking. The best daily record in the Toro tunnel has been 20.6 ft. and the maximum advance in one week, 133 ft. This tunnel is to have an ultimate length of 11,400 ft., of which about 1,100 ft. remained to be driven on Feb. 1. The material traversed is chiefly sandstone and shale, from which considerable flows of water have been met, as much as 450 miner's inches being handled at one time. About 30 per cent of the length has thus far required timbering, and some steel sets have been used instead of standard timbering, very great pressures being set up by swelling due to air slaking of certain formations.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Wall Castings for Cast-Iron Pipe

Sir—In your issue of Feb. 9 there is a letter from Thomas F. Wolfe regarding the article by the writer entitled "Wall Castings for Cast-Iron Pipe," which appeared on p. 1017 of your issue of Dec. 22, 1927.

The writer is aware that the Cast Iron Pipe Research Association has included in its new "Handbook of Cast Iron Pipe" on p. 195, Table 81, dimensions and weights of their standard wall castings up to 24 in. diameter and having a standard laying length of 30 in. On the last line of p. 195 there is a note stating that other lengths can be furnished.

The tables in my article were developed from the practice followed by experienced engineers on work to which careful consideration was given and where the over-all lengths of the castings used were made equal to the corresponding wall thicknesses, in the manner shown by the drawings in the article.

It was the writer's intention to make clear at the beginning of the article that the castings listed therein were special. Accordingly the dimensions of bells given conform with those of Class B bells for special castings as given by the "Standard Specifications for Cast Iron Water Pipe and Special Castings" of the American Water Works Association, adopted May 12, 1908, in the fifth and seventh columns, headed "Diam. of Sockets, Special Castings" and "Depth of Sockets, Special Castings" respectively, of the table on p. 8. In the two columns just mentioned, dimensions are given for classes A, B, C and D of all sizes from 4 to 60 in. diameter, and for the sizes from 4 to 12 in. diameter these dimensions are the same for both Class B and Class D. The thickness of the bells as given in the last two columns of the table on p. 8 under the headings "b" and "C" respectively, differ slightly for Classes B and D in the 10 and 12-in. sizes.

ROBERT T. REGESTER,
Designing Engineer on Sewage Disposal,
Division of Engineering and Construction.

Columbus, Ohio,
March 5, 1928.

Proper Placing of Traffic Signals

Sir—Anent the Moore article (p. 238, Feb. 9, 1928) on Highway Signals. Let me register a protest against the fetish that red means stop, particularly at the point of stop. In barely a hundred years of railroad evolution, where the man at the throttle (wheel) does no steering but goes forward, backward or stands still on a guiding track, it may have come to mean that. Even if it has, that is no reason to wrench it out of its special case and apply it generally.

In several thousand years' evolution of navigation, more directly comparable to vehicle movement since the guiding mind chooses direction as well as movement, it has never come to have any such meaning. I imagine that even in this railroad age there are as many people in the world who navigate and are familiar with navigation as there are who work on railroads.

Railroad practice sets one signal for one moving body. Navigation and highway practice sets one signal for as many moving bodies as may happen along. The cases are not comparable and may lead a faddist far astray in generalizing from a particular. The man in the locomotive cab can see to the right better than he can see straight ahead or, particularly, to any degree to the left; the man in the boat or the motor car is better engaged in looking ahead than 90 deg. to the right, say within 45 deg. of each side of his direction.

Slow moving vehicular traffic is supposed to keep close to right curb. A delivery car or moving van at the head of the stopped column does not have to be very big to blot out for everybody but its own driver a near-side signal 8 ft. from the ground and leave vehicles in the second or third columns or to the rear guessing as to what they are supposed to be doing.

The ideal situation for a signal would seem to be at intersection of thoroughfare axes and overhead (suspended), but trolley wires, etc., may destroy the possibility. Next would seem to be a central post if traffic relation to capacity is not so great as to make the space thus deadened too valuable. Next would seem to be a far-side corner signal as within the line of vision of the greatest number of affected drivers and surely within that of the drivers of the leading row of cars, from whom those behind can take their cue until visibility opens up to them.

The foregoing is primarily for vehicular traffic; pedestrian traffic could be fairly well served by elevated central signals but is probably best handled with synchronized but entirely separate signals at the near side (which can be mounted on the same posts as for vehicles), so distinct that a strange motorist in addition to "looking over the lot" would not have to stop to sort out what he sees.

A grain of common sense injected into a lot of this plain, fancy and assorted science that is running around after being turned loose might help take the string out of the G.B.S. aphorism that all professions are mere conspiracies against the laity. You made a good start with the Ramey Williams Mississippi article Jan. 19. Keep it up. L. H. RAND,

San Francisco, Calif., Colonel, Corps of Engineers,
Feb. 15, 1928. U. S. Army, retired.

Early Ships of the Navy

Sir—In Vol. 91 of the *Transactions* of the American Society of Civil Engineers, 1927, is contained the address of the president, George S. Davison. I know Mr. Davison wishes to have printed correct figures in any statement he makes. On page 553 the speech states:

> In 1781 a merchant ship, the "Alfred," was acquired by the United States government and was constituted the first (and only) ship of the Navy. John Paul Jones served as first lieutenant on this vessel.

When one thinks of the troubles and trials of John Paul Jones when he was building the "Ranger" at Portsmouth, N. H., and actually sailed in command of the "Ranger" in 1777, a date of 1781 given out in an official publication of the American Society of Civil Engineers does not look very good. Please note the following from de Koven's Life of John Paul Jones, pages 82 to 84:

> On Oct. 13, 1775, Congress passed a resolution to purchase two swift sailing vessels. With the passing of this resolution the American Navy was founded. The "Lexington" and the "Reprisal" were purchased. On Oct. 30, 1775, the "Alfred" and "Columbus" were ordered and added to the infant fleet.

The "Lexington" was not the first ship which was purchased by full congressional authority, but it was actually the first which sailed under government orders. John Barry was her captain, appointed Dec. 7, and sailed in the early part of February, 1776, under orders of Oct. 13.

On page 554 of Mr. Davison's address is this statement: "As an evidence of progress, it should be stated that there is now being built an American vessel of 22,000 tons, the speed of which will be such that she can make the transatlantic trip in seven days." In view of the fact that both the "Lusitania" and "Mauretania" have made the transatlantic trip from Queenstown to New York in about four days and eleven hours, and in view of the fact that the "Leviathan" has a displacement of about 64,100 tons and that the "Majestic" has a displacement of about 64,800 tons, evidence of progress is apparently being applied with a minus sign.

The important point in the foregoing is that the "Alfred" was not the first ship, nor was she the only ship of the Navy, and was not acquired in 1781. It is believed that the great interest taken by people on our seacoast in Navy Day is sufficient warrant for supplying these corrections.

Naval Operating Base, L. F. BELLINGER,
Norfolk, Va., Lieut.-Commander (C.E.C.), U.S.N.
Nov. 14, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Group Meeting of A.S.T.M. Committees Held in Washington

Committees Hold Record Three-Day Session With 475 Members Present

THE regular spring group meeting of the committees of the American Society for Testing Materials was held in Washington, D. C., March 21-23. The group-meeting plan, originated a few years ago to conserve the time and expense of members serving on a number of committees, this year brought together a record attendance, with 475 members present, representing 26 committees. With the many subcommittee meetings that were necessary the number of separate meetings held during the three days totaled 94.

The following notes cover the progress reported in a number of the committees:

COMMITTEE PROGRESS

Steel—Committee A-1 eliminated the clause appearing in its specifications stating that structural steel grade shall be used for billet steel concrete-reinforcement bars unless otherwise specified. For the chemical analysis of plain carbon steel, proposed methods for the determination of aluminum are being included. A note regarding permissible overweight of plates ordered to thickness as used in the A.R.E.A. general specifications for steel railway bridges was approved.

Corrosion of Iron and Steel—Committee A-5 issued a new specification covering zinc-coated barbed wire and zinc-coated steel wire strand. The committee has under consideration the preparation of a specification for zinc-coated highway guard wire. A subcommittee has been at work formulating new methods for accelerated tests. Further results were reported on the sheet exposure tests which have been in progress for eleven years.

Cement—Committee C-1 centered much of its discussion around the tests of the past year or more which have been conducted by 47 laboratories on 32 brands of cement. Specimens made from a neat paste containing 42 per cent water have been tested with results quite as variable as those obtained with the usual tamped and troweled specimens.

Brick—Committee C-3 took action to submit new tentative specifications to the society for concrete brick and for sand-lime brick. The present tentative specifications for building brick

(*Continued on p. 530*)

Progress on Water Supply Project for Albany, N. Y.

A bond issue of $3,000,000 to finance the first part of the project for an additional supply of water for Albany, N. Y., has been authorized by the city council. It is expected that bids will soon be invited for the diversion dam on Basic Creek. A bill authorizing the sale of water from the projected works outside Albany has passed the legislature and been signed by the governor.

Court Upholds Colorado Home Product Law

A Denver contractor, Peter F. Bossie, who sued for an injunction restraining the mayor of Denver from signing a contract to erect a city and county building, the specifications of which called for foreign marble, stones, etc., won his case through all the lower courts, and on March 19 the state Superior Court ordered that the specifications be rewritten to specify Colorado stone and marble. The intent of the law is that for any state work, including buildings, roads, etc., done in Colorado, the material used must be a Colorado product if it is suitable and the price is not more than 5 per cent above the cost of a foreign article.

New York Health Department Again Controls Sewerage Plans

Power to approve all plans for sewerage and sewage disposal systems in New York State, except those for state institutions, is returned to the Department of Health by Chapter 436 of the Laws of 1928, supplemented by Chapters 219, 344, 395 and 420, all of which have been approved by Governor Smith. This power was originally and for many years vested in the department named, but in 1921 it was transferred to the state engineer and later to the Department of Public Works, although permits for construction have continued to be issued by the commissioner of health. When the change was made in 1921, a division of sanitation was created in place of the previous division of engineering, the latter headed by Theodore Horton. Mr. Horton was transferred to the office of the state engineer and continued to have charge of plans for sewerage and sewage disposal. He will still have charge of the design of sewage-works for state institutions. Charles A. Holmquist is chief of the division of sanitation of the health department, as he has been since the reorganization in 1921.

Builders Blamed For Failure of St. Francis Dam

Governor's Commission Finds Dam Built on Rock Which Softened in Water

FAILURE of the St. Francis Dam was due to defective foundations, according to a report of the committee appointed by Governor Young of California to report upon the cause of failure. The committee finds nothing to indicate that the accepted theory of the gravity-type dam is in error.

The committee stated that samples of rock taken from the foundations of the western end quickly softened in water and turned to a mushy or granular mass. This rock was found to be of such a nature that it appeared hard and rock-like when dry, although defective in compressive strength. With such a formation, says the report, failure was inevitable unless water could have been kept from reaching the foundations.

The committee believes that all such structures should be erected and maintained under state supervision.

REPAIR WORK UNDER WAY

The list of dead and missing in the St. Francis disaster was placed at 450 on March 25. By that date repair work was well under way, being expedited materially by the $1,000,000 fund voted on March 20 by the Los Angeles City Council to aid in clearing away débris and repairing flood damage. A plan was worked out between the city and the Los Angeles Chapter, Associated General Contractors of America, whereby 1,000 workmen went into the flood district with tractors, trucks, power shovels and hoists to clear up débris, recover partly buried automobiles and aid individuals generally in salvage work. The contractors association selected firms equipped to undertake this work, which will be done without profit. State highway damage in the Santa Clara Valley is estimated at $150,000. The area of the farm land damaged is estimated to exceed 10,000 acres. About 4 miles of the Saugus branch of the Southern Pacific Railroad was damaged or destroyed. Repairs on the three aqueduct breaks below Power House No. 2 had been completed and the aqueduct was reported again in serviceable condition March 24.

Investigations of the disaster include the following: Elwood Mead is chairman of the committee appointed by the Los Angeles City Council, other members being L. C. Hill, Lansing H.

Beach and D. C. Henny. The Los Angeles County district attorney appointed a committee of six, Col. C. T. Leeds, chairman, four members being engineers and two geologists. Another committee of six, appointed by Governor Young of California, consists of four engineers and two geologists, A. J. Wiley, chairman. A committee of three engineers and geologists has been appointed by the Los Angeles Bureau of Water Works and Supply and two other committees of two members each are making reports for the California Industrial Accident Commission and and for the Ventura County Supervisors. Only Governor Young's committee has announced its findings, but the coroner's jury, of whose nine members six are engineers or contractors, has been holding public hearings.

Witnesses testified at the coroner's hearings that although the reservoir had been filled previously, the dam had not settled nor deflected from its alignment. The outlets through the dam consisted of five 30-in. pipes, and even if the danger had been recognized a few days before the flood, their capacity would not have been sufficient to have changed the situation materially, although, of course, residents in the valley below could have been warned. Mr. Mulholland said on the stand that he could not account for the failure of the dam. He had based his opinion as to its safety on previous experience in building nineteen dams. His only suggestions as to the possible cause was that "we must have overlooked something." He answered negatively a question regarding the rebuilding of the dam. Workmen engaged in the construction of the dam testified that foundations had been carried 10 to 12 ft. into the rock formation on the sides of the dam and in the channel 20 ft. into the rock, or about 30 ft. below stream bed. Before construction ten core drill borings were put down 25 ft. in the stream bed. These were later connected to a common outlet. No drainage was provided under the remainder of dam. Some concrete fragments from the left bank with schist still adhering are now reported found as far downstream as any from the right bank.

Seepage Under the Dam

On the subject of seepage under the dam, Mr. Mulholland is reported by the *Evening Express*, Los Angeles, to have said: "I went to the dam because Tony Harshelfeger, the keeper, who was drowned, notified me that the water was muddy and that there was a new leak. Engineer Van Norman and myself went there to look at a new leak that had been reported. This leak was on the west side and was washing dirt down along an old unused construction road." As to the quantity of water Mr. Mulholland said that it was about four or five miner's inches (about 6 or 7 cu.ft. per minute). He also stated that it was clear as crystal and indicated no erosion.

Major Connolly to Leave Work on Mississippi River

Major Donald H. Connolly, district engineer, First and Second Mississippi River Districts, U. S. Army, with headquarters at Memphis, Tenn., is to be relieved of that duty in August in order that he may be sent to the Army War College for one year. A similar order relieving Major Connolly from duty on the Mississippi River was issued last year, but was rescinded following a storm of protest over taking him away at such a critical time. Major Connolly has been in charge of the Memphis office about six years. He was graduated from West Point in the class of 1910. During the war he served on the General Staff in France for two years.

New Jersey Sewage Association Holds Two-Day Meeting

Continued growth of the New Jersey Sewage Works Association was attested by an attendance of 150 persons at the thirteenth annual meeting, held at Trenton March 23-24. This was the first two-day session held by the organization and the first time supplymen had an exhibit. Besides the large representation from all over New Jersey and from New York City and Philadelphia, there were men from as far afield as Boston, Hamilton, Ont., Columbus, Minneapolis, Richmond and Pittsburgh. Engineers were numerous among those at the convention.

The new president is Edward Shissler, Haddon Heights, N. J. John R. Downes, of the Plainfield Joint District, with offices at Bound Brook, N. J., was continued as secretary.

During the four sessions of the convention there were papers and discussions on improving the appearance of sewage-works, by Mr. Schissler and by John F. Skinner, Rochester, N. Y.

Experiments on seeding tanks with cow manure, horse manure and muck from a polluted stream were found to present difficulties in each case, reported Dr. William Rudolfs, chief of the New Jersey Sewage Experiment Station, New Brunswick, N. J., who added that the best method of seeding is to get active sludge from the nearest tank available. Dr. Rudolfs also reported that extensive experiments had failed to find any economically practicable method of psychoda or sewage fly control by the use of chemicals; flooding is effective.

The extensive use by north Jersey seaside resorts of one-story settling tanks and ocean outfalls discharging 1,000 ft. from shore in 10 to 12 ft. of water was described by I. R. Riker, senior sanitary engineer, New Jersey State Department of Health. In their earlier years the tanks used were too nearly square, too heavily baffled and sometimes buried too deep to give good results. Latterly they follow more nearly the standard design for one-story septic tanks. Covered sludge-drying beds built above the tanks are sometimes used. An extension of this arrangement at seaside towns seems likely, as also of chlorination, provision for the ultimate use of which is required by the state.

That New Jersey municipalities have had power, since the home rule act of 1917, to charge sewer rentals was shown in a paper by Charles MacDonald, chief clerk, bureau of engineering, New Jersey Department of Health. Information elicited in the ensuing discussion seemed to show that comparatively little use of this power has been made, and that chiefly where municipalities have bought out sewage companies which were charging for the use of the sewers.

Most of a lengthy evening session was given over to a detailed technical discussion of standards for B.O.D. determinations. Such differences of practice and opinion were disclosed that Dr. Rudolfs, who presided over the discussion, was made chairman of a committee, of his own subsequent choice, to investigate this subject.

American Committee of World Engineering Congress Organized

Dr. Elmer A. Sperry, of Brooklyn, was elected chairman of the American Committee of the World Engineering Congress to be held at Tokio, Japan, next year. Formal organization and election took place in Washington last week. Herbert Hoover is honorary chairman of the committee.

Technical Men Still Await Action on Pay Increase

No action has yet been taken by the Board of Estimate and Apportionment of New York City regarding readjustment of salaries for technical men employed by the city. Last October $600,000 was voted for this purpose.

Dissatisfied because of the five months' delay in making the readjustment, about 1,000 visited the City Hall on March 8 to make a demonstration before the board. This demonstration was under the auspices of the Union of Technical Men, Local 37. The delegation was not well received by Mayor Walker, who was presiding at the meeting of the board, and he rather testily announced that the board could not be intimidated and that any requests the technical men wished to make should be sent through regular channels.

This demonstration has caused a considerable controversy between the Union of Technical Men and representatives of the engineering societies of the city. The latter contend that the action was undignified, but the former counter with the assertion that dignified tactics have been barren of results and that it was necessary to show the mayor that the protest did not come from a small group.

Meanwhile the Board of Estimate awaits a report from the director of the budget, to whom the matter has been referred.

Contract Repair Work for Chicago Streets

An experimental return to the contract system for street repairs has been approved by the Chicago City Council, this system to be employed on all work north of Madison St. till the end of the year. The city's street department will continue to handle repair work south of Madison St.

Indiana Water-Works Men Hold Annual Meeting

Several phases of the municipal water-supply problem were discussed actively at the annual meeting of the Indiana section of the American Water Works Association, held at Purdue University, on March 15 and 16. A paper on "Elevated Water Storage," by George H. Fenkell, general manager of the department of water supply at Detroit, Mich., dealt with the special conditions determining the Detroit layout as well as with the general principles involved.

Relations between the American Water Works Association and its various sections were discussed by Beekman C. Little, secretary of the association. In view of the growth of the association, regional meetings are suggested to take the place of the usual national meeting, in order that a larger number of members may be brought to meetings.

A paper by W. C. Mabee, chief engineer of the Indianapolis Water Company, dealing with an investigation of "unaccounted-for" water, showed a variation in different cities of from 5 to 60 per cent of the total pumped, the average being 25 per cent.

A paper on "Water Softening in Small Cities," by Charles P. Hoover, chemist in charge of the water-purification plant of Columbus, Ohio, showed that many cities are building plants for softening the entire supply and that already thirteen such plants are in operation in Ohio. While a hardness of 120 p.p.m. causes complaint on the part of the consumer, 90 p.p.m. seems to be satisfactory. He advised a point between 70 and 80 p.p.m. and that this be held fairly constant, since variations are noted by the user and complaints result.

One session was devoted to round-table discussions on various subjects. In the discussion of the cost of service connections it developed that, in general, public plants make a rather moderate flat charge, which is not refunded or applied to future bills, while private plants make a somewhat higher charge at the time the service is placed and refund it when actual service is established, or it is applied to bills for water furnished. In either case the service is considered to be a part of the utility plant.

Officers for 1928-29 include: President, C. E. Stewart, superintendent of water works, Muncie, Ind.; vice-president, I. L. Miller, Indianapolis; secretary, C. K. Calvert, 1902 North New Jersey St., Indianapolis, Ind.

Washington Notes

President Said to Disapprove New Flood-Control Bill Reported in the House, Changing Board Personnel

By Paul Wooton
Washington Correspondent

AFTER having reported out a flood-control bill providing for limited local contributions, the commerce committee of the Senate, on the insistence of Senator Hawes, of Missouri, recalled the bill and by a vote of eight to five altered it so as to eliminate all local co-operation in the construction of new works. Even the requirement for the furnishing of rights-of-way for levees on the main river was stricken out. Much more liberal treatment was accorded tributaries. An amendment was adopted requiring the United States to pay just compensation for all property used, damaged or destroyed in carrying out the flood-control plan, "including all expenditures by persons, corporations and public service corporations made necessary to adjust or conform their property or to relocate same."

Another far-reaching amendment provides for additional surveys before any works other than leeves and revetments are undertaken between Baton Rouge and Cape Girardeau. This is aimed at the diversion across northeastern Louisiana and the diversion of additional water through the Atchafalaya. The amendment also requires that lands adjacent to a floodway must receive the same degree of protection as those along the main river.

The new bill met with prompt disapproval at the White House. The President is represented as entertaining the fear that this may mean that comprehensive legislation will not be adopted at this session. It is apparent that the new bill will have determined opposition from administration quarters. The President also is said to have expressed his displeasure with a change made in the board which is to harmonize engineering differences. That board originally was to consist of the Chief of Engineers, the president of the Mississippi River Commission and a civilian engineer. In the bill as rewritten it is to consist of two civilians and the Secretary of War, in addition to the Chief of Engineers and the president of the Mississippi River Commission. No change was made in the appropriation authorized. The amount remains $325,000,000.

Road Congress

The President has signed the joint resolution of the two houses of Congress authorizing him to invite the Permanent International Association of Road Congresses to hold its next meeting in the United States. The meeting probably will be held in Washington in June of next year. The invitation will go to all nations. About 300 delegates are expected to attend. Plans are being formulated under which the delegates would be taken on a tour of ten or more states so as to give them an opportunity to gain a first-hand impression of highway construction under varying conditions.

Nicaragua Canal Surveys

Senator Edge, of New Jersey, has introduced a joint resolution proposing a survey of canal routes in Nicaragua, for the purpose of revising and bringing down to date the report of the Isthmian Canal Commission transmitted to Congress Dec. 4, 1901, and for the purpose of collecting additional information that may have a bearing on determining the most practicable route by way of the San Juan River and the Great Lake of Nicaragua, or by any other route that will include a suitable harbor at each terminus.

Bay Bridge

Objections from the Navy and War Departments to the construction of a bridge over San Francisco Bay north of Hunters Point are expected to prevent the passage of Representative Welch's bill for the construction of a bridge from Rincon Hill to the South Mole of San Antonio estuary. The local authorities, however, made an impressive showing in behalf of the bill before the committee on interstate and foreign commerce of the House.

Marshall to Retire as Head of General Contractors

R. C. Marshall, Jr., for the past eight years general manager of the Associated General Contractors of America, has resigned that position to become president of the Sumner Sollitt Company of Chicago, one of the older construction organizations of the country. General Marshall is to be succeeded by D. A. Garber, who has resigned as president of the North Eastern Construction Company, of New York, a position which he has held since 1904. General Marshall will continue to serve as a member of the executive board of the association.

During the war General Marshall served as chief of the Construction Division of the Army in charge of the emergency military building program in this country. Mr. Garber has been active in the association's affairs since pre-organization days and served as its first president.

Engineering Foundation Receives Gift of $10,000

A gift of $10,000 to the United Engineering Society for its engineering foundation endowment fund has been made by the Central Hudson Gas & Electric Corporation. A point of interest with regard to the gift is that it indirectly results from the success of the company's accident prevention campaign and the money was earned by more efficient operation.

A.S.T.M. Committees Meet in Washington

(*Continued from p. 527*)

and also those for paving brick are being revised, and the important subject of weathering is being recommended for study by a joint committee.

Hollow Masonry Building Units—Committee C-10 in considering the present standard specifications for hollow burned-clay load-bearing wall tile recommended that the two-cell 5x8x12-in. tile generally used for backing up brick walls of buildings be eliminated. It was also proposed that very hard tile and tile having an absorption of less than 6 per cent should not be used for fire walls.

Preservative Coatings for Structural Materials—A report that was made on the painted panels exposed at Altoona, Pa., in connection with the investigation by Committee D-1 of proper methods of preparation of steel plates for painting indicated that the tests are nearing completion.

Road and Paving Materials—Committee D-4 reported on both bituminous and non-bituminous materials. A complete form of practice for the inspection of bituminous paving plants engaged in the production of all classes of bituminous paving mixtures was presented and recommended for adoption. In connection with non-bituminous pavements, a report dealing with materials, proportioning and curing methods for portland cement concrete pavements and bases was presented and recommended for publication with a view to eliciting criticism. The A.E.S.C. sectional committee on methods of test for road and paving materials, with the same personnel as that of Committee D-4, moved to submit several test methods for bituminous materials to the American Engineering Standards Committee for approval.

Phosphur and Sulphur in Steel—The joint committee on investigation of the effect of phosphorus and sulphur in steel has had test specimens made to show (1) effect of residual sulphur in forging steels and (2) effect of residual phosphorus in casting steels. The committee has also given favorable consideration to suggestions that have been made by the American Petroleum Institute and the manufacturers of steel pipe that there be studied the effect of added phosphorus upon the properties of low-carbon steel such as is used in the manufacture of welded pipe, having a carbon range of approximately 0.06 to 0.12 per cent.

Zinc Coating of Iron and Steel—The sectional committee on specifications for zinc coating of iron and steel, which functions under the procedure of the American Engineering Standards Committee and is sponsored by the A.S.T.M., discussed a specification for zinc coating of iron and steel sheets and a tentative specification for zinc coating of structural steel shapes, plates, bars and their products.

Cast-Iron Pipe—The sectional committee on specifications for cast-iron pipe, sponsored jointly by the A.W.W.A., N.E.W.W.A., American Gas Association and the A.S.T.M., reported through its technical committee No. 3 that a valuable series of corrosion tests is being made at the Massachusetts Institute of Technology. A report was presented on the studies so far made to determine the relative carrying capacities at different ages of pipe with coal-tar, asphalt and cement linings.

Honor to Clemens Herschel on Eighty-sixth Birthday

Luncheon and Testimonial Given to Eminent Hydraulic Engineer, Past President of the Am. Soc. C. E.

In honor of the 86th birthday of Clemens Herschel, 26 engineers gathered at luncheon at the Engineers Club, New York City, on March 23. After the luncheon, which was graced with a properly lighted birthday cake, an illuminated address was presented to Mr. Herschel bearing the signatures of those giving the luncheon.

As toastmaster, J. Waldo Smith characterized Mr. Herschel as "eminent hydraulic engineer, author and linguist." Mr. Herschel expressed thanks for the distinction and expressed the hope that those present would keep on working to make the standard of engineers higher and still higher.

As having had the longest acquaintance with Mr. Herschel, the next speaker was E. D. Adams, a director of one of the early power companies at Niagara Falls. Mr. Herschel, said Mr. Adams, did not agree with the British advisers, Lord Kelvin and George F. Deacon, that the mouth of the tunnel should be submerged. Mr. Herschel was sent to London and either convinced or silenced the two.

John Cook, who had known Mr. Herschel since 1878, said that Mr. Herschel, at Holyoke, was one of the first to bring about charges for the use of surplus water for power. He also restricted the use of water at times of low flow and penalized by ten times the regular rate any who exceeded their allotment. An irate customer, after fruitless expostulation, quoted some lines about being "crowned with a little brief authority" and making angels weep. Mr. Herschel rejoined that if the angels wept any surplus tears they would have to pay for them.

It was in 1883, said Waldo Smith, that he wrote to Mr. Herschel expressing a wish to leave the Essex Company, at Lawrence, where he had been for a little over a year, and to join Mr. Herschel at Holyoke for the sake of greater experience and to earn money for his technical schooling. "Mr. Herschel said, 'Come on,' and I went." After speaking of Mr. Herschel's water-charge plan at Holyoke and his wheel tests, for which waterwheels came from all over the country, Mr. Smith spoke of the development of the Venturi meter, which made it possible for water-works men to know what they are doing and which has been "more helpful to water-works men than any other invention of which I know."

Allen Hazen testified that in their friendship of 35 years he had learned more from Mr. Herschel than from any man outside his own professional family, the latter including Hiram F. Mills. Thaddeus Merriman characterized Mr. Herschel as the man who made Venturi famous. J. F. O'Rourke said Mr. Herschel was not only a master in his own line but one always willing to share his knowledge. Willard Chevalier classed Mr. Herschel with the early engineers who, before the present vast accumulation of engineering knowledge, grappled with and applied fundamentals of science.

Mr. Adams, speaking again just before the gathering broke up, proposed the toast, "In his accomplishments he has satisfied his ambition." Mr. Herschel responded by saying that if he had taken a part in handing on the torch of knowledge it must be remembered that it was once received by him —from James B. Francis, of Lowell, a self-made man who at eighteen had come to America from Wales, where he had worked as a stone mason. Francis went to Lowell, helped build some of the canals there, studied nights, became agent of locks and canals and founded hydraulics. Finally, said Mr. Herschel, "we owe to the example set by our forefathers whatever we have been able to accomplish."

W. A. Slater to Head Lehigh Research

The board of trustees of Lehigh University announces the election of Willis A. Slater, engineer physicist in the Bureau of Standards and chief of the section on masonry construction, as research professor of engineering materials and director of the Fritz Engineering Laboratory in the department of civil engineering. With this appointment, it is announced, an intensive program of scientific research in the materials of engineering will be undertaken by the university.

Professor Slater is a graduate of the University of Illinois, and during the war was engineer physicist in the Bureau of Standards, detailed to the Emergency Fleet Corporation.

Professor Slater participated in the first test ever made to determine the stresses in a reinforced-concrete building in actual service by measurement of the strains in the floor. He has participated in many of the important tests of actual structures which have since been made. In 1925 he was placed in charge of the construction and tests of the Stevenson Creek arch dam, in California.

Engineering Societies

Calendar

Annual Meetings

BUILDING OFFICIALS CONFERENCE OF AMERICA, Springfield, Mass.; Annual Meeting, Detroit, Mich., April 24-27.

AMERICAN WELDING SOCIETY, NEW YORK; Annual Meeting, New York, April 25-27.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

THE MISSOURI VALLEY SECTION of the American Water Works Association will hold its fourteenth annual meeting Oct. 2-5 in Kansas City, Mo.

THE BUILDING OFFICIALS CONFERENCE OF AMERICA will hold its fourteenth annual meeting in the Hotel Statler, Detroit, Mich., April 24-27.

THE FLORIDA SECTION, American Water Works Association, will hold its second annual meeting April 3 and 4, at the San Juan Hotel, Orlando, Fla.

THE ENGINEERING FOUNDATION, New York, has re-elected its officers as follows: Chairman, Lewis Buckley Stillwell; vice-chairmen, Arthur D. Little and George A. Orrok; director and secretary, Alfred D. Flinn; treasurer, Jacob S. Langthorn; assistant treasurer, Henry A. Lardner.

Personal Notes

G. W. HARRIS has been appointed chief engineer of the Atchison, Topeka & Santa Fe Railway System, succeeding the late C. F. W. Felt.

FRED H. DABLER, of Evansville, Ind., a civil engineer in the employ of the Chicago & Eastern Illinois Railroad for the past ten years, has been transferred to Salem, Ill. Mr. Dabler is a graduate of Arkansas University, and previously to his employment by the railroad did private engineering work in Evansville.

MURRAY M. MASON, formerly superintendent of construction for Stone & Webster, Inc., of Boston, Mass., is now connected with Allen J. Saville, Inc., engineering and construction, Richmond, Va., as construction superintendent on the construction of city docks for Richmond.

J. H. CONZELMAN, for the past three years chief engineer of the Natural Rock Asphalt Corporation, of Louisville, Ky., and prior to that assistant to the president of the Kentucky Rock Asphalt Company, has been appointed chief engineer of Alabama Rock Asphalt. Inc., and will make his headquarters at Birmingham, Ala.

ROY W. CRUM, of Ames, Iowa, has been made director of the Highway Research Board of the National Research Council, effective April 1. Mr. Crum was graduated from Iowa State College in 1907, and after serving on the engineer corps of the Pennsylvania Railroad, he returned to Iowa State College as associate professor of civil engineering, in which position he remained twelve years. Since 1919 he has been engineer of materials and tests with the Iowa State Highway Commission.

CALEB M. SAVILLE, chief engineer of the Hartford Water Commission, has received the prize annually awarded to the member of the Connecticut Civil Engineers Association who writes the most valuable scientific paper on an engineering subject during the year. Mr. Saville's paper was entitled "The Future Water Supply of Connecticut" and was delivered before the society several months ago.

Obituary

C. F. GREEVER, superintendent of construction for the Missouri Valley Bridge & Iron Company for 25 years, died on March 8 at Leavenworth, Kan.

DANIEL J. CASEY, former superintendent of public works of Glens Falls, N. Y., and for many years prominently identified with the construction of state highways and the repair of the Champlain division of the Barge Canal, died on March 23 at Utica after several months' illness.

W. THOMAS WOOLEY, former construction engineer, state department of prisons, New York, died March 10, after a long illness. Mr. Wooley was 51 years old. He was city engineer of Schenectady from 1912 to 1913 and served in a similar capacity in Syracuse in 1914 and 1915.

WILLARD BEAHAN, past-president of the Cleveland Engineering Society and formerly a director of the Am.Soc.C.E., died on Feb. 5 in his 74th year. After his graduation from Cornell in 1878 Mr. Beahan engaged in engineering work on the Mississippi River, but later turned to railroad work and became an authority on railroad location, construction and maintenance. He was author of "The Field Practice of Railway Location."

FLEMING RAMSAUR, of Kings Mountain, N. C., died in Charlotte, N. C., on March 9, age 59. Mr. Ramsaur was a widely known engineer throughout the South Atlantic States, where he had been connected with various railway enterprises for the past 30 years. Some of his more important engagements were: Double tracking the Southern Railroad between Danville, Va., and Lynchburg, Va.; construction of the Seaboard Air Line Railroad from Charleston, S. C., to Savannah, Ga., and the extension of the Seaboard Air Line Railroad from Coleman to West Palm Beach, Fla. In addition to railroad work, Mr. Ramsaur at times applied his energies to other works, the most important of which was the construction of the Coquitlam hydraulic fill dam near Vancouver, B. C., of which work he was in charge as chief engineer. At the time of his death Mr. Ramsaur was president of the Jefferson Construction Company of Charleston, S. C., and Baltimore, Md.

GAETANO LANZA, for many years on the faculty of the Massachusetts Institute of Technology, died at his home in Philadelphia on March 22, aged 79 years. Mr. Lanza was born in Boston and received his education in Virginia. He became connected with M.I.T. in 1871 as instructor of mathematics, and was made assistant professor of mathematics in 1872, professor of theoretical and applied mechanics in 1875 and head of the department of mechanical engineering and applied mechanics in 1883. In 1911 he retired from active teaching and was made professor emeritus. Later Mr. Lanza was special consultant in mechanics at the Baldwin Locomotive Works in Philadelphia and associate editor of the *Franklin Institute Journal*.

WILLIAM F. M. GOSS, past-president of the American Society of Mechanical Engineers and former professor of railway engineering and dean of the College of Engineering at the University of Illinois, who was for ten years president of the Railway Car Manufacturers' Association, died on March 24 in New York City in his 69th year. Professor Goss organized the department of practical mechanics at Purdue University in 1879 and remained at that university until 1907, when he went to the University of Illinois. He was in charge of the locomotive-testing plant of the St. Louis Exposition in 1904 and from 1913 to 1915 he was chief engineer of the committee of investigation on smoke abatement and electrification of railway terminals in Chicago. His great contribution to locomotive engineering came while in charge of the department of practical mechanics at Purdue University. Here he installed a full-size locomotive, so mounted that speed and tractive effort could be changed at will, and with this installation he for a decade carried on tests the results of which were transmitted annually to the American Railway Master Mechanics Association and became embodied in improved practice in locomotive design. He was, as the result of this work, one of the few men engaged in laboratory research who could gain the ear and command the co-operation of the old-time railway master mechanic in whose hands in the period preceding 1907 lay the destinies of railway motive power design and operation.

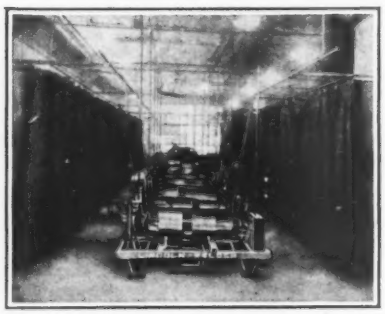
Road Building Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

New Arc Welding School

For a number of years a school of welding has been in existence in the shop of the Lincoln Electric Company, Cleveland, Ohio, because the company has felt it should do everything possible to advance the practical knowledge of welding. This welding school recently has been entirely reorganized and re-equipped and now offers individual instruction free.

In the illustration the equipment of the present school is shown. In line with a series of booths in which the pupils do their work have been placed



a number of standard 200 ampere Lincoln "Stable-Arc" welders. The welding unit that serves each man stands directly before the booth in which he practices. All the wiring except the necessary leads to the electrode holders is concentrated in conduits beneath the floor. The individual compartments are curtained by heavy material so that there may be no chance of the arcs struck by other pupils flashing the men's eyes.

The pupils in the school work under the direction of a trained instructor who teaches them both as a class and as individuals. All the educational work comes under the general direction of A. F. Davis, vice-president. The course lasts thirty days and is given in twelve lessons, as follows:

(1) Contact of the arc, characteristics and manipulation.
(2) Nature of welding rods and depositing materials.
(3) Operation and care of the welding machine.
(4) Nature of vertical and overhead welding.
(5) Testing welds for porosity and strength.
(6) Welds on cast iron and their percentage of strength.
(7) Advantages and future of carbon arc welding.
(8) Welding of copper and bronze castings.
(9) Use and abuse of pressure welding.
(10) Assistance to the human element in "Stable-Arc" welding rod.
(11) Construction of welded machine tools.
(12) Simplicity and strength of welded fixtures.

Business Notes

PERFEX CORPORATION, Milwaukee, announces the opening of a Cleveland office in the Leader Building in charge of A. C. Owen, formerly located at New York. Mr. Owen will have charge of the sales of the company's heavy duty industrial engine radiators both in Ohio and the Eastern states, which he formerly covered.

JOSEPH R. DRANEY, for many years general sales manager of the United States Asphalt Refining Co. and Bitoslag Paving Co., has been appointed general sales representative of the Natural Rock Asphalt Corporation, Louisville, Ky. Mr. Draney was one of the organizers of the Asphalt Association and president of that organization for a number of years.

NATIONAL FIRE PROOFING COMPANY, Pittsburgh, Pa., announces that Sidney F. Heckert has been elected president. Mr. Heckert has been an architect in Pittsburgh for over forty years and has served as a member of the board of directors of the National Fire Proofing Company for a long time, becoming managing director last year. At the present time Mr. Heckert is also president of the Hollow Building Tile Association.

ORTON CRANE & SHOVEL COMPANY, Chicago, at its recent annual meeting re-elected P. A. Orton, Sr., president and general manager, and Harry Shaffer treasurer. P. A. Orton, Jr., formerly in charge of sales in the Chicago territory, was elected vice-president and sales manager, and Herbert Mertz was elected vice-president in charge of sales in the New York territory. Alex Orton, works manager at Huntington, Ind., C. C. Case, Chicago, and J. L. Kenower, Huntington, were elected members of the board of directors.

ALLIS-CHALMERS MFG. COMPANY, Milwaukee, Wis., has purchased the plant and business of the Monarch Tractors Corporation, Springfield, Ill. The tractors will continue to be manufactured in Springfield. Business will be continued in the name of the Monarch Tractors Corporation as a subsidiary of Allis-Chalmers Mfg. Company, and R. W. Gotshall will continue as president, and H. B. Baker as sales manager. Plans for an increase in production are said to be under way. Monarch Tractors Corporation was organized as an Illinois corporation in 1926, formerly having been located in Watertown, Wis. Both Mr. Gotshall and Mr. Baker were previously executives of the Holt Mfg. Company at Peoria.

BARBER-GREENE COMPANY has recently established a new branch office in Cincinnati, Ohio, to be under the supervision of Paul Frederick. Mr. Frederick has been with the company for nine years and comes to Cincinnati from the Barber-Greene office in Detroit.

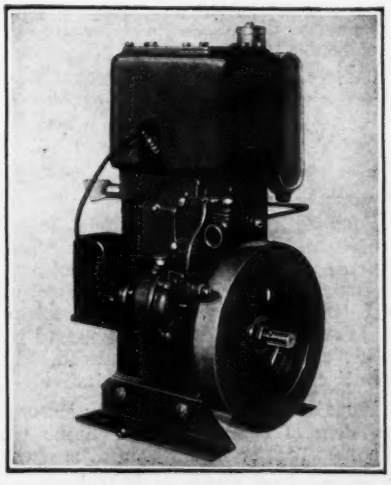
J. W. GLEASON has been made assistant sales manager of the Kalman Steel Company, Chicago. During the last ten years Mr. Gleason has been connected with the General Fireproofing Company and the Freeport Manufacturing Company.

MILWAUKEE CORRUGATING COMPANY, Milwaukee, Wis., announces that Julius A. Pfeiffer, vice-president, Northwestern Expanded Metal Company, Chicago, has been made director of sales of the company's fireproof materials division.

New Developments

Three New Size Engines Added to Company's Line

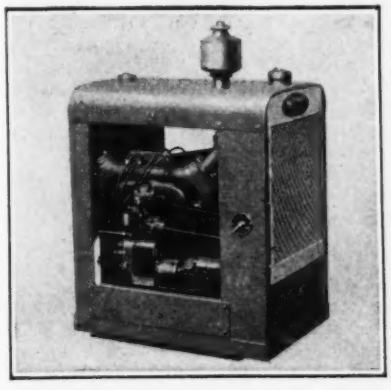
To the present 6-, 9- and 12-hp. two-cylinder Rollr engines, the Novo Engine Company, Lansing, Mich., is adding three new models, a one-cylinder in 3- and 4-hp. sizes, a two-cylinder in an



8-hp. size, and a four-cylinder in a 12- and 16-hp. size.

The two-cylinder 8-hp. unit, 3⅞x4 in., is similar to the company's other Rollr type engines and is available in both hopper-cooled and radiator-cooled designs.

The new single-cylinder engines will be in appearance similar to the two-cylinder engine but with the cylinder block somewhat shorter. The crank-

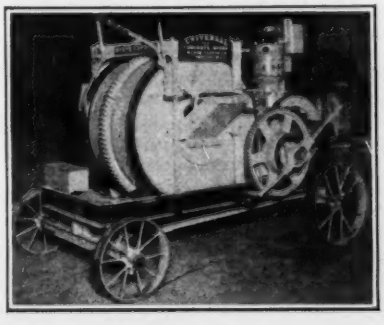


shaft runs on Timken roller bearings, and is so counterbalanced as to reduce vibration to low limits. The positive driven oil pumping system is said to assure proper lubrication at all times.

The new four-cylinder engines are characterized as "doubled-up" two-cylinder engines. The 12-hp. model is a 3x4-in. engine and the 16-hp. model a 3⅛x4-in. engine. Timken roller bearings are used on the crankshaft and power drive shafts, while the "double" 180 deg. throw on the crankshaft is said to eliminate vibration. A positive driven oil pump is used. The power drive shaft gives a choice of either direction of rotation at 300 to 1,200 r.p.m. while the crank drives at any speed from 1,200 to 1,800 r.p.m.

Experiments With Diesel Engine Prove Successful

An experiment was instituted about two years ago in the water-works construction department of the city of Chicago wherein a Diesel engine was installed on a 7-S Marsh-Capron mixer. The experiment was carried out by James J. Verluis, engineer in charge of water-works construction, and during the past two years he has had this piece of equipment in continuous use on sidewalk, foundation and other general work for the city. It has given such satisfactory results that similar engines are being installed on several new pieces of equipment, including a 10-S mixer. The power unit used was a single-cylinder,



5-6-hp. engine, manufactured by the Hill Diesel Engine Co., Lansing, Mich. This company reports that the city has lately placed an order for two 12-hp. two-cylinder Diesels to be installed on larger mixers.

It is understood that a considerable saving in fuel cost over gasoline engines has been effected and except for the necessity of making a patch on the water jacket, which froze during cold weather, the engine has run the entire time without repairs or adjustments of any consequence. No difficulties were reported in starting even in cold weather, and the mixer has been used throughout the test in a normal way and without special attention. The cost of the mixer equipped with the single-cylinder Diesel runs from $200 to $300 higher than the cost of the same mixer with standard gasoline equipment, but the Chicago engineers are said to believe that the increased initial cost is more than offset by better operating performance and economy and by probable longer life.

The Marsh-Capron Co. is not attempting at present to market its mixer with Diesel engine as standard equipment, but of course will supply the mixer without power plant if desired. The Hill Diesel can be applied to the Marsh-Capron mixer with a slight rearrangement of the clutch.

New Model Electric Hand Saw

Designed to be of minimum weight and at the same time powerful and efficient, a new electric hand saw, manufactured by Skilsaw, Inc., Chicago, has been placed on the market. The saw weighs 11 lb. and develops ½ hp. It is designed for cutting lumber up to 2 in. thick and can be used in either hand. This new model "J" supplements a larger type which has been on the market for some time.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WATERWORKS MANUFACTURERS ASSOCIATION, New York City; Annual meeting, San Francisco, Calif., June 11-14.

NATIONAL ASSOCIATION OF RAILROAD TIE PRODUCERS, St. Louis, Mo.; Annual meeting, Hot Springs, Ark., April 24-26.

New Publications

Power Shovels—THEW SHOVEL CO., Lorain, Ohio, has published a new catalog descriptive of its Lorain 75A shovel. Besides giving operating diagrams and specifications for all of the various models, the booklet contains many illustrations and short descriptions of the shovel, crane, dragline and back digger in operation on various construction jobs. The center drive principle of operation is discussed and the various details of each type of machine are illustrated and described. Special attention is given to the new back-digger model and its possible applications.

Alternators—IDEAL ELECTRIC MFG. CO., Mansfield, Ohio, devotes its bulletin No. 151 to its several types of alternators. The booklet contains, besides illustrations, tabular specifications for all the various types. These include a two bearing track type, two bearing pedestal type, three bearing pedestal type, an engine type, and a flywheel type. The bulletin includes also a discussion of the flywheel effect requirement for engine driven alternators.

Hoists—SILENT HOIST WINCH & CRANE CO., INC., Brooklyn, N. Y., in its bulletin No. 27 illustrates a number of models of its capstan winches and drum winches, together with a number of operating views.

Clay Products Standards—EASTERN CLAY PRODUCTS ASSOCIATION, Philadelphia, has recently published the second edition of its standards for salt glazed vitrified sewer pipe and fittings, fireclay flue linings and fittings, stove pipe and fittings, and wall coping and fittings. The booklet also contains the price list effective Jan. 2, 1928.

Paver Specifications—FOOTE COMPANY, INC., Nunda, N. Y., has recently published a catalog and specification describing the features of its 1928 paver. The contents are divided into nine sections, which are indexed so that all section titles are visible at a glance. Each section contains description and illustrations of the particular details considered, such as power transmission, gasoline engine, traction, drums, loading skip, control lever, etc. Among the last pages of dimension tables, charts and other data is a brief account of the advantages of transporting the paver with the new one-man folding top and the company's transport trailer.

Ornamental Street Lighting—GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has recently published a folder, GEA-715A, on its Novalux ornamental units for street lighting. Illustrations are given of some of the various types of lights available, while complete information is given in tabular form regarding sizes for special uses.

Atomic Hydrogen Welding—GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has recently published a pamphlet, GEA-823, describing its equipment for atomic hydrogen arc welding. The equipment, which can be used only for hand welding on a 60-cycle circuit and is claimed to make possible the welding of very thin metals and alloys that hitherto have been considered unweldable, is illustrated and described.

Business Side of Construction

Facts and Events That Affect Cost and Volume

More Million-Dollar Contracts Awarded This Year Than Last

More contracts valued at $1,000,000 or more have been awarded since Jan. 1, 1928, than in the corresponding period in 1927. During 1928 there have been 79 such awards valued at $216,720,000; and in the first twelve weeks of last year, 62 had the value of $201,780,000.

Geographically these awards covered construction in nineteen states in 1928 and twenty-three states in 1927. Illinois, Pennsylvania, California and Missouri show no change over last year in number of large contracts. New York has had twenty-two in 1928 and twelve in 1927, and in Texas there have been nine this year and only one last year.

A large hydro-electric plant in South Carolina contributed $20,000,000 to the 1927 industrial awards, and three New York subway contracts were the principal items in the construction-other-than-buildings classification. New York activity during 1928 has been mainly for large apartment houses and office buildings, and this class of work is the main factor in the large commercial buildings total. Other construction in 1928 is composed principally of large pipe lines in Texas.

MILLION DOLLAR AWARDS DURING FIRST QUARTER

	1928		1927	
	No.	Value	No.	Value
Commercial	58	$156,510,000	47	$123,460,000
Industrial	7	22,040,000	6	47,130,000
Other construction..	14	38,170,000	9	31,190,000
Total.....	79	$216,720,000	62	$201,780,000

Cement Imports Gain; Belgium Leading Shipper

Imports of cement during February, 1928, were greater than last year by 29,219 barrels or 19 per cent. On the basis of value a 5 per cent increase is shown, $211,814 this year compared with $200,680 in February, 1927. These figures are preliminary reports of the Department of Commerce. The greater portion of imports were from Belgium, which supplied 61 per cent in 1928 and 64 per cent in 1927.

During the first two months the total imports for 1928 were 394,393 barrels and last year there were 323,596 barrels, with the value of $554,611 and $470,341 respectively.

Exports during January and February, 1928, amounted to 119,228 barrels valued at $426,495—a quantitative decrease of 19 per cent from 146,750 barrels valued at $488,057 exported during the corresponding period last year.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended March 29, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Mar. 29, 1928..	**38,001**	**62,883**	**100,884**
Mar. 15, 1928	14,416	35,644	50,060
Mar. 24, 1927..	521,376	54,071	575,447
Jan 1, to date:			
1928.....	**241,746**	**549,897**	**791,643**
1927.....	190,423	417,003	607,426

E. N.-R. Index Numbers

Cost		Volume	
Mar. 1, 1928	**204.65**	**February, 1928**	**225**
Feb. 1, 1928	204.65	January, 1928	208
Mar. 1, 1927	208.80	February, 1927	182
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913.....	100.00	1913.....	100

Municipal Issues for Week Third Highest in 1928

Bond offerings for the week ended March 23 totaled $153,399,000, an increase of 91 per cent over last week and 26 per cent over a year ago. Two municipal bond offerings, Detroit (general improvement) and Arkansas (highway), aggregating $30,272,000 made the total offerings for that class of securities exceed all except two other weeks this year.

The industrial group was the largest, constituting about 47 per cent of the total. A United Drug Company issue, $40,000,000, and an Inland Steel issue, $30,000,000, were both refunding operations, as was the Wabash Railway Company $17,867,000 offering.

The public utility group, which led other classes last week, totaled only $11,150,000. Some of the more important offerings are listed below:

	(000 Omitted)	Rate	Yield
Public Utility:			
Kansas City Public Service Co.....	$4,400	6	6.40
South Texas Gas Co...	2,000	6½	6.55
Missouri River, Sioux City Bridge Co.....	1,250	6	6.07
North Continent Utility Corp.....	3,500	5½	5½
Industrial:			
Minneapolis Steel & Machinery Co.....	1,500	6	6
Lancaster Newspapers, Inc.....	600	6	6
Municipal:			
Detroit, Mich.....	17,272	3½, 4¼, 4½	3.70–4.05
Arkansas Highway....	13,000	....	....
Monmouth Co., N. J...	1,036	4½	3.80–3.90
St. Petersburg, Fla....	1,336	5½	4.90
Duluth, Minn.....	900	4	3.70–3.80
Utica, N. Y.....	585	3.90	3¼–4
Borough of Dumont, New Jersey.....	552	4¼–4	4.10–4.20
Chautauqua County, New York.....	2.50	5	3.80
Borough of Cliffside Park, N. J.....	299	4½	4–4.20
Nashville, Tenn.....	185	4–4½	3.80–4.00
Foreign:			
Minas Geraes, Brazil..	8,500	6½	6.69
Isotta Fraschini.....	1,750	7	....
Bank of Silesian Landowners Association	6,000	6	6.70

Contemplated Work Equals Early 1927 Record Figures

For January and February, 1928, construction projects contemplated but not ready for bidding agree remarkably in both number and value with those of 1927. There is a difference of less than one per cent and the similarity is quite consistent both geographically and for the classes of work.

In the two months of 1928 there were 2,655 projects valued at $1,095,763,000, the average being $414,000. The figures for 1927 are 2,689 projects, worth $1,103,080,000, the average being $411,000. Thus there were only 34 fewer projects reported this year than last and the difference in money value is only $7,000,000 out of more than a billion total. The principal falling off is in the Middle West, where the value of the proposed work this year is only 52 per cent of last year's. In gaging Mid-West activity, however, it is important to note that in point of numbers there are 540 projects this year, compared with 523 last year. There is an extraordinary agreement between this year and last for the rest of the West. In the vast region between the Mississippi River and the Pacific Ocean 1,125 projects have been reported this year, compared with 1,151 last year. The 1928 value was $457,000,000, compared with $323,000,000 in the first two months of 1927.

The same remarkable agreement between this year's planning and last year's is to be found in the case of the number and value of projects by classes. Consider the case of water-works, in which class this year 143 projects were reported worth $44,000,000, compared with 142 projects worth $50,000,000 in 1927. There were 51 excavation projects, against 53 last year, although there has been a distinct decline in value. For roads and streets, the most consistent of all the classes, there are 506 projects, worth $137,000,000, compared with 533 projects, worth $108,000,000. In the case of industrial buildings, although the value of projects planned is less than last year, the number is about the same. In the case of other buildings ($150,000 and up), $541,000,000 worth are planned this year, compared with $518,000,000 worth last year, and the average value is $475,000, compared with $428,000.

PROPOSED WORK BY CLASSES
(000 omitted from value)

	1928		1927	
	No.	Value	No.	Value
Water-works...	143	$44,233	142	$50,451
Sewers.....	178	41,859	149	45,090
Bridges.....	85	50,955	99	24,257
Excavation, drainage.....	51	9,654	53	29,700
Streets and roads.....	506	136,707	533	108,285
Industrial buildings.....	271	69,054	287	102,358
Other buildings	1,169	540,751	1,217	517,746
Federal government.....	40	15,449	32	9,667
Unclassified...	212	187,101	177	215,526
Total.....	2,655	$1,095,763	2,689	$1,103,080